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West African Maize Research Unit

SECOND ANNUAL REPORT

1954

COMMONWEALTH MYCOLOGICAL INSTITUTE
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WEST AFRICAN
MAIZE RESEARCH UNIT

SECOND ANNUAL REPORT

1954

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STAFF LIST

As at 31st December, 1954

Geneticist—Officer-in-Charge ..	W. R. Stanton, B.Sc.(Readg.), Ph.D.(Lond.).
Mycologist	R. H. Cammack, B.Sc. Hons.(St. Andrews).

SENIOR SCIENTIFIC OFFICER'S REPORT

This report, the second Annual Report of the Unit, covers the period 1st January to 31st December, 1954. Studies have continued on the investigations mentioned in the 1953 report with additions in the field of study of air-spora, the inheritance of resistance to *Puccinia polysora*, the search for resistance to stem-borers and a study of the indigenous maize types.

The field work was slightly disrupted by labour troubles at planting time and this reduced the number of trials at the Ibadan centre. The 1954 yield trials have been published separately to avoid a bulky appendix of tables in this report.

Staff

Senior Staff

The Senior Scientific Officer was on leave from March to June, 1954, and the Scientific Officer was on leave from June to October. These leaves had a serious effect on the work of the Unit during the year. This adverse effect should be less in future years with the full establishment and the benefits of trained junior staff. Study courses were attended at Rothamsted (Statistics Department) and the Commonwealth Mycological Institute by the Senior Scientific Officer and the Scientific Officer respectively.

Junior Staff

Changes have occurred during the year in the establishment of Agricultural Assistants. Mr. Okereke is continuing his studies at the University College, Ibadan, and he, and three other students, worked with the Unit during the summer vacation. It has now been arranged that all established staff shall be supernumerary members of the Federal Department of Agriculture, Nigeria. This permits recruiting from any part of Nigeria and at the same time ensures the future position of the Junior Staff.

During the year five assistants have visited the Unit for training (two from Department of Agriculture, Gold Coast, one from University College of Gold Coast, two from Department of Agriculture, Eastern Region, Nigeria). The two assistants from the Gold Coast who were with the Unit during 1953 returned for a short period during 1954 to help with records and for briefing in the conduct of the work in the Gold Coast. It is to be regretted that Sierra Leone has been unable to send any Junior Staff to the Unit for training owing to the shortage of Agricultural Assistants in that territory.

Visits

As far as possible arrangements are made so that each regional headquarters is visited twice a year by one or other senior officer and that a senior officer should visit the Gold

Coast every three months to arrange, in particular, the work at Kwadaso. Liaison is maintained with the Director of Agriculture, Dahomey, while in transit to the Gold Coast.

Visits in 1954 were reduced due to leave. However, the Gold Coast was visited by the Scientific Officer in April and by the Senior Scientific Officer in November. The latter went to the Northern Region, Nigeria, in September.

Visitors

Numerous visitors have been to the Unit in the course of visits to the Department of Agriculture. A list is given in the Federal Department of Agriculture, Nigeria, Reports. Of particular value was the visit of Mr. E. B. Martyn (Principal Specialist Officer, Mycology, Gold Coast Department of Agriculture). Messrs. Plant Protection Limited's staff have visited the Unit on a number of occasions and have supplied experimental quantities of fungicides. They are also co-operating on the problems of seed-dressing. Snr. Thomaz de Carvalho (Plant Pathologist, Mozambique) studied with the Unit for a fortnight in December. Mr. Maurer and Miss Harrison (Botanists, Northern Region), and Mr. Tuley (Botanist, Eastern Region) paid short visits to note methods and to discuss maize work in their respective regions.

Publications

During the year two memoranda were produced to provide advance information of the *Puccinia polysora* resistance of Trinidad lines (Memorandum No. 2, West African Maize Rust Research Unit) and on soil blocks (Memorandum No. 3). The mycologist presented a paper to the Commonwealth Mycological Conference which was published as an abstract in the Conference Proceedings. Publication is not yet complete of the Proceedings of the Ninth International Genetical Congress, 1953, which contains an abstract of a paper on maize rust given at the Conference. It is expected that publication will be completed by mid-1955.

Machinery

Glasshouse Machinery

Seedling culture work is now based on a standardized, electrically sterilized compost and the seedlings are planted in soil blocks. A controlled environment chamber using natural illumination is expected, so that experiments on temperature and humidity control can be completed before the plans are finally settled for a new range of glasshouses. In the meantime, experiments are being conducted in an old greenhouse in which the shading has been reduced and a thermostatically operated extractor-fan installed.

Irrigation

The necessary machinery has been received for overhead irrigation of four acres (Rainmaster equipment), but its installation is being withheld pending a clarification of the Unit's tenure of land on Moor Plantation.

Air-conditioned Store

This store has been in continuous operation throughout the year and is now fully equipped with metal racks fitted with galvanized wire baskets. The shelled maize is

stored in cotton bags. All maize is fumigated before going into store and, so far, no pest infestations have occurred. The design of the racks allows free circulation of the air during normal running, or fumigation of the store should any infestation develop. The store has proved invaluable for maintaining viability of samples.

Polythene Sealer

A machine has been acquired for heat sealing sheet polythene (alkathene). This has been used for constructing infection chambers for pathology studies and for sealing polythene bags for the despatch of maize overseas. It protects the maize completely against high atmospheric humidity in transit and subsequent storage.

Seed Distribution and Receipt

During the year a number of collections of maize were received. Of particular importance are a group of inbreds from Professor Fenaroli (Bergamo, Italy), corn-borer resistant lines from Dr. Rinke (Minnesota, U.S.A.) and genetic stocks from Dr. Smith (Illinois collection of genetic stocks). A supplement to the 1953, First Annual Report, acquisition list will be appended to the 1955 report.

RESEARCH

PLANT BREEDING AND GENETICS

Trials of New Material

Trinidad lines. (Acquisition Nos. 180-272.) Tests on these lines are reported in appropriate sections of a separate report, "West African Maize Rust Research Unit Yield Trials, 1954", and the best lines are being multiplied for sub-station trials in 1955. Further observations are being made on all lines, in 1955, before discarding.

South African lines. (Acquisition Nos. 274-703.) As will be seen from the report by the mycologist, these lines failed to mature. This is a common failing of non-tropical lines at Ibadan. An approximate estimate of their rust resistance has, however, been made.

Italian lines. A collection of inbreds (Acquisition Nos. 716-737 and 753-755) from Professor Fenaroli of the Instituto de Maiscultura, Bergamo, are still under test. They will be useful in introducing yielding ability and increasing the range of maturity time, but as with all acquisitions from temperate climates, difficulty was experienced in growing the lines to maturity because of disease. Similar difficulties were encountered with the "Asgrow" hybrids (Acquisition Nos. 704-706).

Corn-borer (*Pyrausta nubialis*) resistant lines. (Acquisition Nos. 710-715.) In order to multiply these for further study and to obtain F_1 seed with other lines it was necessary to protect the plants against rust attack by spraying.

Out-Station Trials

Trials have been conducted at centres in the Northern Guinea Savannah, Southern Guinea Savannah, derived Savannah and Forest Zones of the three Regions of Nigeria and the Gold Coast. These have been supervised, as far as possible, by agricultural assistants who had previously received supplementary training in this Unit. The recent increases in specialist officers (Plant Breeding) in the several Departments of Agriculture facilitate proper supervision of trials.

Breeding Procedure

The results of this work will be given in a separate report. It must be emphasized that there will be an inevitable gap of several years between distribution for regional testing of primary-tested material and material which has been produced and subsequently stabilized in a hybridization programme.

Breeding for helminthosporium and stem-borer resistance

The Unit is observing all properties of the environment and their effect on maize yield, as mentioned by Mr. Rhind in his preface to the First Annual Report. Among the numerous pests and diseases of maize in West Africa, helminthosporium leaf disease and stem-borer attack give evidence of being both widespread and significant in reducing yield.

Preliminary observations on the effects of these organisms are described in the Plant Pathology and Entomology Sections of this report.

Genetic Studies

The arrival of a controlled environment chamber designed by the Unit is awaited to study the effect of various factors on the expression of rust resistance. This is also a necessary prerequisite to the analysis of differences in pathogenicity of the fungus.

As part of the standardization of the greenhouse technique soil blocks are being used and experiments have been carried out to select a suitable standard compost. This procedure is described under "methods" in the greenhouse studies in this report. Recommendations are also given on devices for using extractor fans in keeping insect-proof greenhouses cool without loss of light intensity.

Genetic Stocks

A number of genetic stocks have been received from Dr. Smith of Cornell University. (It is noted that the original collection of stocks has been transferred to Illinois. Maize Genetics Newsletter, 27th March, 1955.) Others will be obtained as space and staff are available to permit their care and maintenance. The general high susceptibility of these lines to rust and other leaf diseases has necessitated special cultural measures, and stocks suitable for West Africa are being produced by crossing with Maize Unit inbreds resistant to *Puccinia polysora.*

In connection with these inheritance studies the mycologist has continued to investigate rust reaction, in relation to the ontogeny of the plant, as the first true-leaf has been found to be an unreliable index of reaction in some genotypes.

Plant Pathology

Observations on the Maize Collection

An important function of this section is the routine observation of disease attack on all acquisition, breeding and trial material. In addition to rust assessment the mycologist has been investigating the assessment of leaf damage due to *Helminthosporium turcicum.* Papers on these observations will be found in the Pathology Section of this report. A check list of maize fungi is being prepared and a preliminary list is included in the report. The introduction of temperate zone inbreds has brought to light a number of fungi as pathogens which do not attack local maize or lines brought from a similar environment.

Rust Assay Plots

These have again been laid down in Nigeria and the Gold Coast, in the early and late rains, and have been of value not only in confirming hypotheses on the rust's behaviour but in demonstrating the effect of different environments on the general behaviour of the different lines of maize used in these assays.

Observations on the Air-spora

Other aspects of the epidemiology have been receiving attention. A special study is being made of the air-spora using a continuous recording Spore Trap to measure seasonal fluctuations in the level of typical maize pathogens. Modifications in technique were

necessary to overcome the effects of heat and high humidity on the trapping medium. These are described in detail later.

Effect of Rust on Yield

Using frequent sprayings of the fungicide, tetramethyl thiuram disulphide, rust attack has been partially controlled. The results of this study have been important in aiding interpretation of changes in yield due to times of planting, etc.

Sequential Plots

The sequential plots, used for time of planting studies described in the First Annual Report, have been continued and have repeated the patterns of the previous year. The procedure has been modified to include plots treated with nitrogen and phosphate as the former nutrient fluctuates widely in the growing season and the level of the latter has been shown to be significant in its effect on rust intensity.

Taxonomy

In concluding a review of the pathological work, the study by the mycologist of the morphological variations in *Puccinia polysora* uredospores in the collection at the Commonwealth Mycological Institute is noteworthy. No significant geographical variation in the mean spore size of samples collected in West Africa was found. It is hoped that these measurements will be made in other parts of Africa.

Entomology

Stem-borers

As an introduction to the study of the control of stem-borers, the Senior Specialist, Gold Coast, has contributed a review, in the form of a map, of his work on the West African stem-borers. These are not the same genus as the European corn-borer but the hypothesis is being tested that maize unfavourable to one group of borers may also be unfavourable to the other owing to the similarity of their biology.

Miscellaneous

Progress reports are given in this section on miscellaneous studies on which more information is required for the integration of the research programme.

Firstly, the variation from year to year in the severity of rust epidemics may be attributed in part to annual variation in climate. The only data available on this, over a sufficient period, is for rainfall. An analysis of the variation from year to year, at two centres, will be given in a later report. The Unit is indebted to the Meteorological Department, Nigeria, for the necessary data.

Secondly, a long term project was started this year on the study of the variations in West African maizes. A first report is given (page 33) of the method of sampling and the information collected with each sample.

Finally, all literature references in this report have been combined in a bibliography at the end of the report.

GREENHOUSE STUDIES ON RESISTANCE TO *PUCCINIA POLYSORA*

Advances in the techniques for testing seedlings for rust resistance in the greenhouse have been made since the previous report. In particular, further investigations have been made into optimum compost for healthy seedlings and into methods of increasing the light intensity in the greenhouse without corresponding increases in temperature. The revised methods are given in detail below.

Methods

The Greenhouse

Successful growth of maize seedlings in the greenhouse necessitates admitting as much light as possible. Excessive insolation, however, causes high temperatures during the day and if shading is employed to control high day temperatures, to be effective, it has to be taken to a degree which is detrimental to the growth of seedlings. This difficulty was overcome by installing a powerful extractor fan. This allowed a large area of glass to be retained in the roof. The greenhouse has the following dimensions:

Height 2.75 m. to ridge, 2.14 m. to eaves.
Base 3.05 × 9.15 m., (volume 84.8 cu. m.).
Roof $\frac{2}{3}$ glass, $\frac{1}{3}$ wood boarding.
Extractor fan, "Trojan" 12 in., situated on the gable immediately under the ridge, extracting 38.8 cu. m. of air per minute.

A shaded "Sunvic" thermostat positioned on a beam in the centre of the greenhouse at the height of the eaves brought the fan into operation when the temperature reached 85°F. Under full sunlight conditions the fan maintained temperatures below 95°F. These conditions of high light intensity and moderate day temperatures gave good seedling growth. High humidity was maintained by soaking a half inch thick layer of fine gravel laid down each side of the greenhouse.

Seedling Cultivation

Seeds were planted singly in soil blocks (May, 1954) having the following composition:

Compost: 7 parts sterlized black cocoa soil, *Egbeda* series (Vine, 1953)
3 parts mahogany sawdust
2 parts washed river sand
} by volume

To each cubic metre of compost was added 1.36 kg. of ammonium sulphate, 1.36 kg. of superphosphate, 0.68 kg. of potassium sulphate and 0.34 kg. of lime. Further details of the experiments leading to the above formulation are given in the West African Maize Rust Research Unit Memorandum No. 3 (1954). The compost maintains healthy growth of seedlings for three weeks, thereafter the blocks are watered with a complete nutrient solution.

The seedlings were arranged in aluminium seed trays, 40 × 25 cm., each tray containing eight soil blocks. The trays were laid on one metre high metal trolleys to facilitate movement in the greenhouse.

Inoculation

Preliminary methods of inoculation have been mentioned in the First Annual Report 1953 (1955). The standard method now in use consists of wetting the leaves by passing them through moistened fingers and then spreading uredospores with a soft brush on to the upper third of the second and third leaves at the stage when the third leaf has grown clear. The seedlings are then sprayed lightly with water from an atomiser and covered with a polythene hood for 48 hours. Spraying the inside of the hood ensures high humidity throughout the incubation period.

Assessment

Seedlings are assessed on the tenth day after inoculation, by which time the pustules are mature. Storey and Ryland (1955) found that pustules took fourteen days to mature in East Africa. The original qualitative assessment scale, (Stanton & Cammack, 1953), has been modified after extensive use and now agrees closely with the scale employed by Storey and Ryland (1954).

Class	*	
00	0	Host immune. No detectable effects on inoculated leaves.
0	0;	Host showing high resistance. Hypersensitive flecking. No necrosis.
1	01	Host resistant. Uredosori minute, abortive and isolated, surrounded by sharply defined necrotic areas which are visible on the under-surface of the leaf.
2	1	Necrotic areas tending to merge into limited but distinct marginal chlorosis. Pustules small, rupturing the epidermis to show very few uredospores.
4	4	Host susceptible. Uredosori large, numerous in extensive clusters. Chlorosis indistinct or absent.

* Storey and Ryland Scale

Storey and Ryland (loc. cit.) use Class X to define reactions lying between class "1" and class "4" of their scale. In the light of experience of greenhouse testing at Ibadan reactions in Class X are unreliable in selection of breeding lines. Class X reactions are used in critical studies of maize lines but for practical purposes, and especially where doubt exists, they are classified as "4".

Immunity class "OO" of the new scale, has not been found among varieties tested at Ibadan, and the true "O" reaction is confined to derivatives of Mexico 13 Acq. 95 (SLP 20 4A), received originally from the Rockefeller Research Centre (AFRO 24 of Storey).

The Effect of Nutrition on Assessment Values

Storey and Ryland (loc. cit.) have stressed the necessity for maintaining a controlled level of nutrients during growth of seedlings in the greenhouse. Blane (1953) observed in field trials in the Gold Coast that phosphate increased the incidence of rust. An experiment in the greenhouse at Ibadan with two levels of phosphate, 1.4 and 5.6 kg. per cubic metre of compost, showed an increase in pustule frequency with the higher concentration. The leaves of the seedlings were inoculated by brushing on a thick

aqueous suspension of uredospores, and subsequent pustule formation recorded as pustule density per unit leaf area. Pustule numbers were counted with a "perspex" graticule placed over the leaf surface. Infected seedlings grown in the higher level of phosphate showed a 30% increase in pustule density over those grown in the lower level of phosphate.

The more serious result of different phosphate levels was the effect on the qualitative assessment due to changes in the amount of chlorosis. The higher level of phosphate appeared to reduce the chlorotic area around the pustule and increase the pustule size. Seedlings in compost with amounts of phosphate below the minimum requirements for normal growth were often seen to have the chlorotic haloes around pustules masked by the typical colouration of phosphate deficiency. These observations necessitated the use of an accurately balanced compost in the soil blocks, and the maintenance of the fertility level by the controlled application of a nutrient solution.

Juvenile and Adult Reactions

The large number of acquisitions tested in the greenhouse, and the probability of their inclusion in the breeding programme, made it necessary to test if juvenile qualitative reactions were also typical of the adult plant in the field.

The seedlings, grown in soil blocks, were inoculated as before. After assessment the infected leaves were cut off and the plants transferred to the field. Adult assessment was done at the time of emergence of the tassel and again at the milk-ripe stage. Juvenile and adult reactions of a selection of varieties tested are given in Table 1.

In some instances the juvenile scoring was found to be an indication of the behaviour of the adult in the field. The departures from identity are shown in the last column of Table I. Without exception the fully susceptible reaction, class "4", in the seedling was also shown by the mature plant. Resistant reactions in the seedlings were not always an indication of resistance in mature plants and it has been observed that the level of resistance in the adult is often less than that displayed by the seedling and, in some cases, juvenile resistance gives a fully susceptible mature plant reaction.

New Varieties and Derivatives

During 1954 approximately 300 new acquisitions including E.A.A.F.R.O., "Asgrow", Trinidad, Italian and Florida lines, and derivatives from existing varieties were tested in the greenhouse. The revised qualitative assessment key was used. The identity of the lines tested and their qualitative seedling reactions are given in Appendix I.

With the exceptions of derivatives from the parent Acq. 95 Mex. 13 (S.L.P. 20-4a), none of the present W.A.M.R.U. lines show as high a level of resistance as obtained by the East African inbreds derived from A.F.R.O. 29. 1511. Mex. 13 has consistently shown flecking without any accompanying necrosis. Certain lines derived from Acq. 83 Mexico I (Coahuila 8) and Acq. 87 Mex. 5 (Rocamex 520c) have given uniform class I reactions.

Inheritance of Resistance

Several workers have studied the inheritance of resistance of maize to the most common of its rusts, *Puccinia sorghi*, but no study had been made of resistance to the second rust of maize, *Puccinia polysora*, until an epidemic of this disease occurred in West Africa.

TABLE 1

Seedling and Adult Qualitative Rust Reactions to *Puccinia polysora*

Progeny reference	Variety and pedigree	Seedling reaction	Adult reaction	Increase in susceptibility
2047	Mex. 1	1	2	+1
1712	Mex. 2	4	4	
1065	Mex. June	4	4	
1738	Mex. 4 $S_1 \# S_2$	2	4	+2
1658	Mex. 5	1	2	+1
1743	Mex. 7	2	4	+2
1568	Mex. 13	1	1	
810	Mex. 16 S_4	2	2	
1526	Mex. $17 \#_2 S_1$	2	2	
1704	Mex. 21 $S_1 \#$	4	4	
1706	Mex. $22 \# S_1$	2	4	+2
Acq. 810	EAAFRO 53191	2	2	
,, 811	EAAFRO 53193	1	2	+1
,, 812	EAAFRO 53194	2	2	
,, 813	EAAFRO 53197	1	2	+1
1844	Br. 129 Haiti $\# S_1$	2	2	
1856	Br. 132 Haiti $\# S_2$	1	2	+1
1849	Br. 125 Haiti $\# S_1$	2	4	+2
1847	Br. 130 Haiti $\# S_1$	2	2	
Acq. 685	June—165	4	4	
,, 684	June—141	4	4	
,, 675	Tiquisate—10	2	2	
,, 679	Yellow Tuxpan—12	4	4	

Preliminary reports on the location of sources of resistance to the rust have been given by Stanton and Cammack (1953) and evidence for monofactorial inheritance of a factor for resistance has been presented by Storey and Ryland (1954).

Resistance to Puccinia Sorghi

Mains (1924) tested a number of inbreds at the United States Department of Agriculture, Division of Crops and Diseases, Experiment Station at La Fayette, Indiana, and found that three varieties had produced inbreds among which were highly resistant plants. Further study revealed that these inbreds would differentiate three physiologic forms. His classification is given in Table 2. (Mains, 1931).

Demerec (1926) tested a number of lines for linkage of the genes for resistance with a series of genes. (Listed in Table 3.)

TABLE 2

Variety	Accession No.	Reaction to physiologic forms		
		1	3	4
Golden Bantam	996R	0-1	3-4	4
Golden Rod	959R	0-2	3-4	4
Howling Mob	983R	0-1	3-4	4
Golden Glow	208R	0-1	0-1	4
,,	202R	0-1	0-1	4

TABLE 3

Lines	Genes.	Chromosomes
Albino	w_{11}	9
Liguleless	lg_1	2
Shrunken endosperm ..	sh_1	9
Yellow endosperm ..	y_1	6
Virescent seedling, 3 and 4	v_3, v_4	5, 2
Dwarf	d_1	3
Sugary	su_1	4

(The symbols for the genes are standardized after Weijer, 1952.)

Demerec concluded that whilst the rust reactions were sufficiently discrete to be suitable for linkage studies, no linkage was demonstrable. A further report was issued (Mains, 1931), but linkage was first demonstrated by Rhoades in 1935.

Rhoades detected the location cytologically by the following method. Pollen from plants homozygous for resistance to rust race 3 was irradiated and applied to susceptible plants. The susceptible F_1, which could only be susceptible by a gene deficiency from the pollen parent, was examined cytologically and susceptibility was found to occur on plants bearing a deficiency in the short arm of chromosome 10. The position of the gene was subsequently checked genetically using eight distinct trisomics carrying marker genes and by crosses with normal plants carrying marker genes on the other two chromosomes.

Further information on the marker genes on chromosome 10 has been given by Rhoades (1939). Recently, a number of studies have been made on genes for disease resistance (Yarnell, 1954), but their linkage relationships, with the exception of helminthosporium resistance (Ullstrop & Brunson, 1949) and smut resistance, (Saboe & Hayes, 1941) have not been demonstrated.

Breeding Materials and Methods

Resistant Parents

It was postulated by Stanton and Cammack (1953) that sources of resistance were most likely to occur in the endemic zone of *P. polysora*. This theory was supported by the

results of infection tests on a collection of maize from the New and Old Worlds (Stanton & Cammack, 1955). On the basis of these tests attention was concentrated on three members of a group of lines received from the Rockefeller Research Centre, Mexico City.

Four lines, as used by Storey and Ryland (op. cit.), have been received and tested once. These have not yet been incorporated in the studies but it appears that they are more susceptible, in reaction, in West Africa than in East Africa where they were selected. Storey and Ryland obtained a second source of resistance from lines received from Turrialba, Costa Rica. Selections from these lines appear to be highly resistant.

Susceptible Parents

In 1953, crosses were made between the Mexico lines, a number of local varieties and varieties which had been collected for yield trials by the Department of Agriculture, Nigeria. Rust observations were made on the mature plants using a quantitative key, designed primarily for surveying adult resistance in the maize collection for the assessment of the effect of the amount of rust on yield and the rate of development of different varieties. A qualitative key was used in the greenhouse assessments conforming to the standard description terminology of reaction type for *Puccinia graminis*, (Stakman & Levine, 1922). It must be emphasized that such a qualitative key implies discrete genetic steps in the resistance, the existence of which must be regarded as tentative.

In 1954 a number of marker stocks were received from the Maize Genetic Co-operation by the kindness of Dr. C. A. B. Smith. These stocks were multiplied by selfing or intercrossing and used as one parent in crosses with resistant lines selected in the breeding work. Difficulty was experienced in bringing some of these stocks to maturity although they were grown in an insect-proof greenhouse in sterile compost. All proved highly susceptible to rust and it was necessary to spray at frequent intervals with tetramethyl thiuram disulphide.

It was possible to grow the F_1 generation in the field but it appears that it will be desirable to develop genetic stocks more suited to West African conditions for future work.

The parental F_1 and F_2 lines were inoculated by the spore-smearing method of Newton and Johnson (1952). Details of modifications were given by Stanton and Cammack (1955). All families were started in soil blocks and inoculated on the third leaf. After assessment the inoculated leaf was removed and the plants put out in the field. There they were allowed to grow to maturity and become naturally infected with rust. In the field this does not take place until the plants are about to tassel, if they are planted at the normal time. This reinfection served as a check to the greenhouse inoculations, though in the lines used no departures from the greenhouse results were found. The analyses have been done, therefore, on the greenhouse rust assessments.

Results

The results of these tests are given in Table 4 . This table sets out the segregations of two point tests using the factors indicated. An analysis of chi-squared is given for individual and joint segregation in each family.

TABLE 4

Tests of linkage between marker genes and rust resistance

Families involving an inbred from Acq. 98 from Mex. Var. 39-66B-1 (Mex. 16).
O=Observed. E=Expected.

Family 1 × Illinois 4^{6}, test for linkage with **C.** (Chr. 9, purple aleurone.)
Segregation of the double heterozygote.

	C Rpp	**C rpp**	**c Rpp**	**c rpp**	Total
O	297	68	123	42	530
E	298.125	99.375	99.375	33.125	

Analysis of chi-squared	*Component*	x^2	*Probability*
	Rust	5.80	0.02-0.01
	Purple aleurone	2.66	0.20-0.10
	Linkage	1.51	0.30-0.20

Family 2 × Illinois 4^{8} carrying **R** (Chr. 9, purple plant).
Segregation of the double heterozygote.

	R Rpp	**R rpp**	**r Rpp**	**r rpp**	Total
O	290	98	76	34	498
E	280.125	93.375	93.375	31.125	

Analysis of chi-squared	*Component*	x^2	*Probability*
	Rust	1.04	0.5-0.3
	Plant colour	0.92	0.5-0.3
	Linkage	0.20	0.7-0.5

Family 3 × Illinois 4^{11} carrying **Og** (Chr. 10, old gold stripe).
Segregation of the double heterozygote.
(Normal type here indicated with '+'.)

	+ Rpp	**+ rpp**	**Og Rpp**	**Og rpp**	Total
O	208	58	50	5	321
E	180.5625	60.1875	60.1875	20.0625	

Analysis of chi-squared	*Component*	x^2	*Probability*
	Rust	0.41	0.7-0.5
	Old gold stripe	1.81	0.2-0.1
	Linkage	2.64	0.2-0.1

Families involving an inbred from Acq. 95 from Mex. Var. S.L.P. 20-4A (Mex. 13).

Family 4 × Illinois 4[8] (see Family 2).
Backcross to the recessive parent.

	R Rpp	**R rpp**	**r Rpp**	**r rpp**	Total
O	20	19	23	17	79
E	19.75	19.75	19.75	19.75	

Analysis of chi-squared

Component	x^2	*Probability*
Rust	0.00	0.99
Plant colour	0.32	0.7-0.5
Linkage	0.12	0.95-0.90

Family 5 × Illinois 11[6] carrying **gl**$_1$ (Chr. 7, glossy seedling one).
Segregation of the double heterozygote.
(Normal type here indicated with '+'.)

	+ Rpp	**+ rpp**	**gl Rpp**	**gl rpp**	Total
O	212	62	42	13	329
E	185.0625	61.6875	61.6875	20.5625	

Analysis of chi-squared

Component	x^2	*Probability*
Rust	0.54	0.5-0.3
Seedling	3.01	0.1-0.05
Linkage	0.41	0.7-0.5

Family 6 × Illinois 6[1] carrying **ij** (Chr. 7, iojap stripe).
In this family there were a number of white seedlings and lethals (row O_1). Under certain conditions the homozygote **ijij** can cause these and they have been added to the "**ij**" classes (row O_2) in the proportion showing in the survivors.
(Normal type here indicated with "+".)

	+ Rpp	**+ rpp**	**ij Rpp**	**ij rpp**	Unclassified
O_1	248	85	9	7	27 white seedlings and 52 non-emergents.
O_2	248	85	52.3125	40.6875	
E_2	240.75	80.25	80.25	26.75	Total 428

O_1=Unclassified seedlings separate.
O_2=Unclassified seedlings added in 9:7 ratio to recessive **ij** classes.
E_2=Expected segregation (no linkage) based on the total 428.

Analysis of chi-squared

Component	x^2	*Probability*
Rust	0.95	0.5-0.3
Iojap	8.44	0.01
Linkage	0.31	0.7-0.5

Conclusion

Rust Segregation

In both Mex. 16 and Mex. 13 families, rust segregation fits a 3:1 ratio. The chi-squared values for the former families are higher due to an excess of recessives.

Marker Gene Segregations

With the exception of "glossy seedling" and "iojap stripe", these fit 3:1 ratio. With glossy seedling segregation, the observed values would have been exceeded only once in twenty times. It is suspected that some of the glossy seedlings may have been classified as "normal", although classification appeared to be correct in the greenhouse at the "first true leaf" stage.

Family 6

Weijer, quoting from Jenkins (1924) (and unpub.) states that iojap stripe may throw completely white and lethal seedlings. This appears to be the only explanation of the extra, unclassified class in this family and it will be seen that when these seedlings are included in the total from which the expected values are calculated, the normal classes fit the expected segregation. Further, the analysis of chi-squared shows the departures from expected are due entirely to the disturbed iojap segregation.

From these figures, no indication of linkage has been found for *Puccinia polysora* resistance in the marker genes used. It would appear that care is required in the choice of marker genes for studies under West African conditions and it cannot be assumed that their expression will be similar to that shown in the area where the stocks were produced. Helminthosporium affected the stocks used and it will be necessary to produce marker stocks which are more vigorous and helminthosporium resistant under the conditions prevailing here.

A PRELIMINARY LIST OF MAIZE FUNGI AND DISEASES IN NIGERIA

Fungal diseases of maize in Nigeria are numerous and extensively distributed. Local methods of husbandry encourage the incidence of fungi. The crops generally suffer from malnutrition and in the forest areas the absence, in many instances, of a rotational system often results in successive maize crops being taken from the same site. Crop debris is commonly left on the ground from one season to the next, affording a medium for fungal growth with subsequent infection of the next crop.

The system of rust assay plots planted throughout Nigeria enabled the Unit, with the valuable assistance of members of staff of the Nigerian Department of Agriculture, to obtain preliminary information on the numbers, intensity and distribution of the maize pathogens of economic importance. The following list is far from complete and only includes fungi affecting maize husbandry.

In general, pathogens are prevalent on maize growing in the humid coastal and rain forest areas and are less troublesome in the drier areas of the interior.

I wish to thank the Director and Staff of the Commonwealth Mycological Institute for their assistance in the identification of specimens.

Chytridiaceae
Physoderma maydis Miyabe, on culms, outer sheaths and leaves.

Mucoraceae
Rhizopus spp., on germinating maize grains.
Sphaeriaceae
Cochliobolus heterostrophus (Dreschl.) Dreschl., on leaves.

Hypocreaceae
Gibberella zeae (Schw.) Petch., on husks and male inflorescences.

Pucciniaceae
Puccinia polysora Underw., on leaves and stalks.
Puccinia sorghi Schw., on leaves.

Ustilaginaceae
Ustilago zeae (Beckm.) Ung., on all aerial parts.

Thelephoraceae
Corticium solani (Prill. and Delacr.) Bourd. and Galz., on cobs.

Agaricaceae
Marasmius sp., on leaves.

Fungi Imperfecti

Phomaceae
Botryodiplodia theobromae Pat., on ears.
Darluca filum (Biv.—Bern. ex Fr.) Cast., (hyperparasitic on rusts).
Diplodia macrospora Earle, on ears and leaves.
Phoma insidiosa Tassi, on husks.

Moniliaceae
Aspergillus spp., on germinating maize grains.
Penicillium spp., on germinating maize grains.
Cephalosporium acremonium Corda, on germinating maize grains.

Dematiaceae
Curvularia lunata (Wakker) Boed., on leaves.
Helminthosporium turcicum Pass., on leaves.
Nigrospora oryzae (Berk. and Br.) Petch, on leaves and ears.
Nigrospora sphaerica (Sacc.) Mason, on leaves and ears.

Tuberculariaceae
Fusarium moniliforme Sheld. (Macro and micro-conidial forms of *Gibberella fujikuroi* (Sawada) Wollenw., on old husks and male inflorescences.

Sterile Mycelia
Sclerotium rolfsii Sacc.

Other Diseases

Leaf stripe: Chlorophyll deficiency.
Leaf spotting: Chlorophyll deficiency.
Pellucid ring spot: Cause unknown.
Leaf streak: Virus.

THE INCIDENCE OF FUNGAL DISEASES ON ESTABLISHED AND NEWLY INTRODUCED BREEDING LINES

I. *South African Lines*

In the 1954 early crop, 400 varieties from South Africa were tested in the field. Low germination percentages were observed in all varieties and the mature plants were stunted. In all cases yields were very low. The seedlings were badly attacked by *Ophiobolus heterostrophus*; this disease being recorded on 67% of the stands. Rust onset did not occur until tasselling stage and the intensity of attack was low, possibly due to the poor vegetative vigour of the host. One variety, IYF 8A 337 No. 2, was largely defoliated by a severe attack of *Physoderma maydis* causing fracturing of the leaf bases. *Helminthosporium turcicum* affected most varieties and *Diplodia macrospora* was evident on 22% of the stands.

II. *Mexican Lines*

When introduced in 1952 several of the Mexican varieties showed both juvenile and adult resistance to rust. Notable among these were Mexico 1, 5 and 13. In time, however, their susceptibility (with the exception of Mexico 13) increased, though they have retained their high yielding qualities, and must now be classified as tolerants. Mexican varieties are all highly susceptible to *Helminthosporium turcicum* and also to *Physoderma maydis*. Mexico 13, a variety of high rust resistance has shown 31% of stands infected with brown spot, *P. maydis*, but the disease has not been observed to cause either serious damage or death of the host. *Diplodia macrospora* has been recorded on Mexico 4 and 17 to an extent where considerable leaf damage was sustained and weakened stands resulted. Smut, *Ustilago zeae*, is very rare on Mexican lines.

III. *Trinidad Lines*

The Trinidads as a group can be classified as high order tolerants to rust. They are intermediate in susceptibility to blight, which causes restricted lesions on the leaves and the formation of few conidia. Brown spot is present on all varieties, varying from 8 to 17% plants infected. *Diplodia macrospora* is rare on all varieties except 1820 Br. 167 and 1849 Br. 125 Haiti. Smut, *Ustilago zeae*, is not common, only 0.1 to 0.5% of total stands being infected.

IV. *Italian Lines*

These vary considerably in their susceptibility to rust and none have shown a high level of resistance. The incidence of blight was high without exception in the 39 varieties tested and extensive leaf damage was sustained, generally immediately prior to, or at,

tasselling time. Brown spot infected 3% of the total population but did not develop to a serious level. Smut occurred on 0.8% of stands. The incidence of virus leaf streak was noticeable, causing stunting in 2% of the plants.

V. *Florida Lines*

This group varies in the degree of susceptibility to rust. Two varieties, Acq. 840 Agroceres sementes × Mayorbela—8 and Acq. 842 Agroceres sementes × Mayorbela—10 showed grade 1 resistance and were also resistant to blight. *Diplodia macrospora* was common on the leaves and ears.

VI. *E.A.A.F.R.O. Varieties*

All fifty-four varieties tested showed a high level of resistance to rust and blight in the field, though in many instances this was not borne out in seedling tests in the greenhouse. Only one line, Acq. 783 E.A.A.F.R.O. 248, could be classified as susceptible to blight, all others being highly resistant. One variety, Acq. 813 E.A.A.F.R.O. 53197 (derived from E.A.A.F.R.O. 49), was apparently immune to blight in a recent field trial and is undergoing further tests. This group is also promising due to the low incidence of other diseases. Brown spot occurred in only 0.6% of the total plants and smut was not observed. *Diplodia macrospora* was found on two varieties. A selection of the most disease resistant lines is given below.

Acq.	761	E.A.A.F.R.O.	226	
,,	764	,,	229	
,,	766	,,	231	
,,	774	,,	239	
,,	798	,,	263	
,,	799	,,	264	
,,	800	,,	265	
,,	810	,,	53191	ex E.A.A.F.R.O. 49
,,	811	,,	53193	ex E.A.A.F.R.O. 49
,,	813	,,	53197	ex E.A.A.F.R.O. 49

A PRELIMINARY REPORT ON THE OCCURRENCE OF *HELMINTHOSPORIUM TURCICUM* PASS. IN WEST AFRICA

1. *The Disease*

Leaf blight, known variously as leaf scorch, leaf scald, white blast, helminthosporiose, is one of the most generally distributed and troublesome diseases of maize in West Africa.

The affected parts of the leaf first show as small chlorotic spots, elongating and becoming straw-coloured, then finally grey-brown. The discoloured area is sharply demarcated from the surrounding healthy tissue by a thin brown line. This bounding line is not often apparent in infected maize varieties incorporating a low measure of resistance to the disease. The surface of the infected area eventually becomes covered with grey-green conidiophores.

The effect of the disease on maize varies with prevailing climatic conditions and the stage of growth at the time of infection. Observations made in Nigeria have shown the

incidence of blight to be higher and the production of conidia greater in the humid, coastal rain forest areas than in the drier areas of the interior. Crops planted early in the season, in rain forest zones, generally escape infection until the stage of tassel emergence, and then only the lower leaves are seriously affected. Late plantings (i.e., April, May) can become diseased at an earlier stage, with greater ultimate damage to the mature plant. Several instances have been observed where very early attack has resulted in death of the host.

Blight has been found to be very destructive to newly introduced varieties. First generations of maize imported from Central and South America were noted to be highly susceptible.

2. *Economic Effect*

Reduction in yields due to *H. turcicum* possibly have not been fully appreciated in West Africa. In rain forest areas farmers' plots are often found heavily infected; the fungus being encouraged by the high humidity and the method of husbandry adopted. Where second crops of maize are planted on the same site the incidence of blight is invariably higher than when a rotational system is adopted.

Experimental control of the disease has been partially obtained by spraying with "Nabam" (disodium ethylene bis dithiocarbamate) when the yields were 18% greater than in the untreated plots.

3. *Causal Fungus*

Only the conidial stage is known and sporing occurs freely in culture.

Conidiophores: brown-olivaceous, 100-370μ, up to 9μ, wide, 3 to 8 septate, emerging through stomata in groups of 1 to 4.

Spores: Fusoid, straight or slightly curved, widest at middle and tapering towards each end, 1 to 7 septate, thin hyaline peripheral wall moderately fuliginous, pronounced hilum, germination from polar germ tube at each end, 45 to 130$\times$15 to 28μ.

4. *Assessment of Blight*

A preliminary survey of the incidence of blight, on local and introduced maize varieties, was carried out on the first crop in 1954 and the necessity for a full scale assay became apparent owing to the general occurrence of the disease on the breeding lines. A provisional assessment method based on the percentage leaf area affected was used. The scale had four degrees of infection, namely 5, 10, 15 and 20% of the leaf area showing lesions. A direct comparison was made between a printed key and the 5th, 7th and 9th leaves of the stands at tasselling stage.

The first assessment key, whereas suitable for large scale comparative sampling in the field, required modification for more critical work. During the first survey of all breeding lines it was observed that if the area of leaf affected was taken as the only criterion of the effect of the pathogen on the host, erroneous results ensued. Varietal variation in susceptibility was great and the key had to be modified to allow field assistants to differentiate these variations. In some varieties the initial stage of infection (i.e. the evidence of chlorotic areas) was extensive, but this chlorosis, was often not distinct from the

surrounding healthy tissue. Other varieties had a smaller area of leaf infected but the areas were dried up and production of conidia profuse. This latter type of infection was observed to have a more decisive effect on the plant and subsequent yield due to the reduction in effective leaf area.

At present an assessment key is being tested which measures the percentage leaf area killed by blight. Assessment is done on the 30th day after germination and at tasselling.

5. *Distribution of Resistance to Blight*

Although the original assessment method was experimental it showed clearly the following distribution of susceptibility in the main breeding groups:

Resistant	E.A.A.F.R.O. (Turrialba series)
Intermediate	Florida
	Trinidad
	Italian Inbreds
Susceptible	Mexico
	" Asgrow " lines
	Locals (West African)

6. *The Effect of Blight on Rust Resistant Breeding Lines*

Blight is of major importance in the breeding programme since it has been found that most varieties showing a high order of resistance to *Puccinia polysora* are susceptible to blight and, at present, the relationship between the relative susceptibility of the host to the two pathogens is being investigated. A few examples are given in the following table.

Variety	*Mean rust value* (0–4)	*Mean helminthosporium value* (0–20%)
2043 Mex. 1	1.2	14.6
1648 Mex. 1	1.7	14.8
1805 Mex. 16	1.0	15.1
1649 Mex. 5	1.1	11.9
1332 Mex. 1 × Asg. Wisc. 464	1.0	12.5

It is hoped to secure helminthosporium strain typing lines of maize from America to enable a more critical study of blight to be made in the greenhouse and the field.

FIRST REPORT ON THE USE OF AN AUTOMATIC VOLUMETRIC SPORE TRAP IN THE STUDY OF *PUCCINIA POLYSORA* ON MAIZE

Introduction

In the study of some aspects of the epidemiology of fungal pathogens it is important to be able to ascertain the spore content of the atmosphere. A volumetric spore trap (Hirst, 1952) is being used by the Maize Unit to investigate the behaviour of the spores of the more important diseases occurring on maize at Ibadan, with special reference to *Puccinia polysora*.

Methods

For the following experiments the volumetric trap was sited centrally within 4 acres of maize in an exposed site at Moor Plantation, Ibadan. The trap was mounted on an angle iron tripod with the orifice three metres above ground level (i.e. immediately above the level of the maize tassels). Air was drawn through the trap at a rate of 10 litres per minute by a rotary vacuum pump. The pump was housed in a modified Stevenson's screen placed below the stand and provided with louvres for cooling purposes. The constant running of the motor in the high day temperatures caused slight overheating and excessive vapourization of oil which had to be frequently replenished. The air was passed through an asbestos wool and oil filter between the trap and the pump to remove dust and other air-borne particles. This was found to be essential to prevent excessive wearing of the vanes of the pump.

Preparation of Slides

Spirit cleaned slides were first coated with a thin film of partially hydrolysed polyvinyl acetate ("Solvar"). Several types were tried, the best being "Solvar" 3515 which was least prone to wrinkling on drying out; a troublesome artifact on the trace. At the suggestion of Dr. J. M. Hirst (in correspondence) the use of a priming film was discontinued and an adhesive layer alone proved satisfactory. The slide was coated with adhesive consisting of B.D.H. white paraffin with the addition of 1.5% ceresin wax (congealing point 60°C). This mixture was suitable for use in the high day temperatures and had good optical qualities. The molten wax was dropped on to the slide which was then tilted until the surface was covered, the surplus drained off and the slide placed on a flat surface till the wax congealed. Wax was then removed from strips 3 mm. wide down each side of the slide to facilitate insertion into the slide carrier of the trap.

Mounting the Slides

Hirst (1953) used a mountant consisting of fifty parts of a 20% solution of "Solvar", twenty-five parts lactic acid and twenty-five parts of a 6% solution of phenol. As a probable result of the consistently high humidities at Ibadan this mixture would not set and remained fluid. The formula was modified to incorporate a higher percentage of "Solvar" and less lactic acid and phenol. A satisfactory mixture which still retained its clearing properties was seventy-five parts of 20% "Solvar", fifteen parts lactic acid and ten parts 6% phenol. Applied sparingly the mountant set within a week. In cases where it was necessary to speed up the setting, the slide was transferred to a desiccator one day after mounting.

Counting

All counts have been made on "short traverses" normal to the long axis of the trace at distances corresponding to two hourly intervals and the results are expressed as numbers of spores per cubic metre of air. A convenient counting apparatus was constructed by mounting six bench type tally counters in two banks on a base board. A larger number of counters can be arranged in this manner if required. This arrangement can easily be operated with one hand, leaving the other free for microscope adjustment.

Experiments

1. *The Diurnal Periodicity of the Uredospores of* **Puccinia polysora**

Fluctuations in atmospheric uredospore concentrations over periods of twenty-four hours were determined by counting 14 mm. traverses at distances corresponding to two hourly intervals. The diurnal pattern of fluctuations in spore numbers was obtained from eighty-seven traces representing eighty-seven complete days of sampling.

The diurnal periodicity of the uredospores of *P. polysora* is shown in Fig. 1. The mathematical treatment is the same as that used by Hirst (1953). Each point in the graph, plotted every even hour over the twenty-four hour period, represents the percentage of the peak geometric mean concentration calculated from the eighty-seven samples.

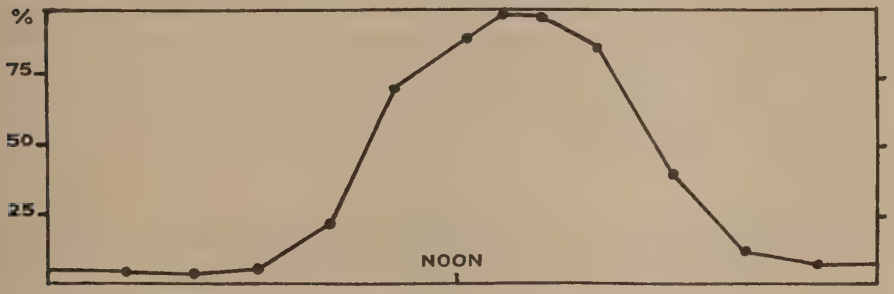


Figure 1. The diurnal periodicity of Uredospores of *Puccinta Polysora*

Due to fluctuations in wind speed it is necessary to apply corrections to spore counts owing to variations in the efficiency of the trap. A sensitive three cup anemometer (electrical contact type) was positioned adjacent to and at the height of the orifice of the trap. The electrical impulses were transmitted to an impulse recorder which charted the fluctuations in wind speed. The mean wind speed was calculated during the period from one hour before to one hour after the time of each count and the correction applied to the number of spores trapped.

Peak concentrations were found to occur between 12.00 and 14.00 hours. A count of 513 uredospores per cubic metre of air was obtained from one trace at 14.00 hours and this is the highest concentration yet recorded.

2. *The Atmospheric Uredospore Content in Relation to the Incidence of Rust in a Maize Plot*

In connection with studies in the epidemiology of *Puccinia polysora* an experiment was designed to investigate the relation between the density of airborne inoculum and the incidence of rust in the crop.

Four acres of maize were planted on 19th April, 1955, at 0.5 metre spacing between plants on the ridge, the ridges being 1 metre apart. A volumetric spore trap was placed in the centre of the plot with its orifice 3 metres above ground level.

Around the trap 100 plants were marked out at 2 metre intervals in the form of a grid and each leaf on every plant labelled and numbered on emergence. On the 19th May the first rust appeared on the plot, one plant showing pustules. From then until the termination of the experiment a continuous record of the air spora was obtained. The

nearest other maize to the experiment was 750 metres, south-east, (the direction of the prevailing wind). It was assumed that the density of inoculum from this source reaching the trap would be insignificant in relation to the density of uredospores released from the maize surrounding the trap. At five day intervals, subsequent to the first appearance of the rust on the crop, the numbers of uredospores caught by the trap were counted. Counts were made in ten 100μ wide traces along the long axis of the slide and calculated as the number of spores per cubic metre of air; this number being the average over a twenty-four hour period. Counts were also made on the day prior to, and the day following, the assessment date and the mean average determined.

The incidence of rust on the marked maize stands was also measured at five day intervals. The amount of rust was expressed as the density of uredosori per unit leaf area. Pustule counts were made with a transparent grid constructed from a 3 in. square of perspex divided by scored cross lines into inch squares, and further sub-divided into $\frac{1}{2}$ in. squares. The graticule was placed over each leaf of the plant in turn and a total pustule count made. Results were expressed as the mean average pustule density per square inch of total leaf surface. The respective values for pustule density and spore load are given in Table 1.

TABLE 1

Values of the mean atmospheric spore load and mean pustule density at five-day intervals. Values below the double line are those recorded after 50% death of the maize population.

Date	Spore load S/Metre^3 (values corrected for efficiency of trap)	Pustule density (P/sq. in.)
3/6/55	10.1	1.5
8/6/55	14.2	5.0
13/6/55	24.2	29.1
18/6/55	36.4	54.7
23/6/55	125.4	82.1
28/6/55	194.0	99.8
3/7/55	194.0	121.5
8/7/55	146.3	126.5
13/7/55	100.1	136.5
18/7/55	98.0	84.0
25/7/55	98.0	50.0

Values of the mean spore load were plotted against mean pustule density for each assessment date as shown in Fig. II. The correlation coefficient between mean pustule density and spore load is 0.92 and the formula for the linear regression of pustule density on spore load is

$$y = 0.15\ (\pm 0.07)\ x + 12.4\ (\pm 15.42)$$

This regression is significant at the 0.1% point. The errors of slope and constant are

Figure II. The incidence of the Uredospore Content of the atmosphere in relation to the amount of rust observed in a field of maize

given for $t(5)$ at the 95% probability level. The values after 50% death have been inserted in the graph but fall outside the limits of the regression line.

This preliminary experiment suggests that a relationship exists between the uredospore content of the air 3 metres above ground level and the incidence of rust on the crop measured as the density of uredosori per unit leaf area.

The correlation only holds within a certain period outside which it is subject to error. At the time of onset of rust on the maize surrounding the trap the number of uredospores discharged is not significantly greater than the numbers of spores trapped which have come from outside sources. Anomalous results are also obtained due to a progressive decline in pustule formation at senescence of the hosts and the abnormal discharge of uredospores from dead tissue. The relationship has been found to hold only until the 50% death point of the maize population. The behaviour of the atmospheric uredospore content in relation to the incidence of rust in the plot at these times is being further investigated.

3. *Fluctuations in the Uredospore Content of the Atmosphere above a Maize Plot from Planting until Maturity*

The volumetric trap was put in operation on the 1st April, giving a continuous record of the air spora. Four acres of maize were planted around the trap on 19th April and from then until harvesting on 12th July the numbers of uredospores of *Puccinia polysora* in the air were determined at five day intervals.

Ten 100μ wide traverses were counted on the long axis of the slide and the daily mean concentration of spores per cubic metre of air calculated. Counts were also made on the day prior to, and the day following, each date, and the mean averages plotted in Fig. III.

On 19th May rust was first observed in the maize plot. Prior to this date the uredospore concentration was low, the spores trapped presumably coming from early planted and irrigated plots of mature maize in the vicinity.The concentration of uredospores began to rise from 5/metre^3 on 19th May to 16/metre^3 by the 50% tasselling stage of the maize population. Thereafter spore numbers increased rapidly to a mean value of 194/metre^3 on the 3rd July, the time of 50% death of the maize stands. The rapid rise in numbers of airborne uredospores after tasselling time corresponds with the observed increase in rate of spread of rust on the upper part of the maize plant after it has entered the reproductive phase. After 3rd July the spore concentration dropped slightly but maintained a high level until the end of the experiment ninety-eight days after planting.

ENTOMOLOGY REPORT

Studies are in progress, jointly with the Gold Coast Department of Agriculture (entomologist Mr. J. Bowden) to assess the resistance of exotic and local maize lines to species of agrotid stem-borers which have been found to be serious pests of maize and other cereal grains of West Africa. It would be premature to report on the evidence at the present stage of the work but, as a first contribution, the map with this report has been compiled, from data supplied by Mr. Bowden, to show the distribution of the species of stem-borers of economic importance. This is of value in defining the problem from the viewpoint of breeding varieties for the different areas.

Stem-borer distribution has been related in the map to the vegetation zones and it will be noted that the habitats of the different species are closely related to these zones. Thus, as for disease distribution, these ecological zones are of value in defining the breeding problem.

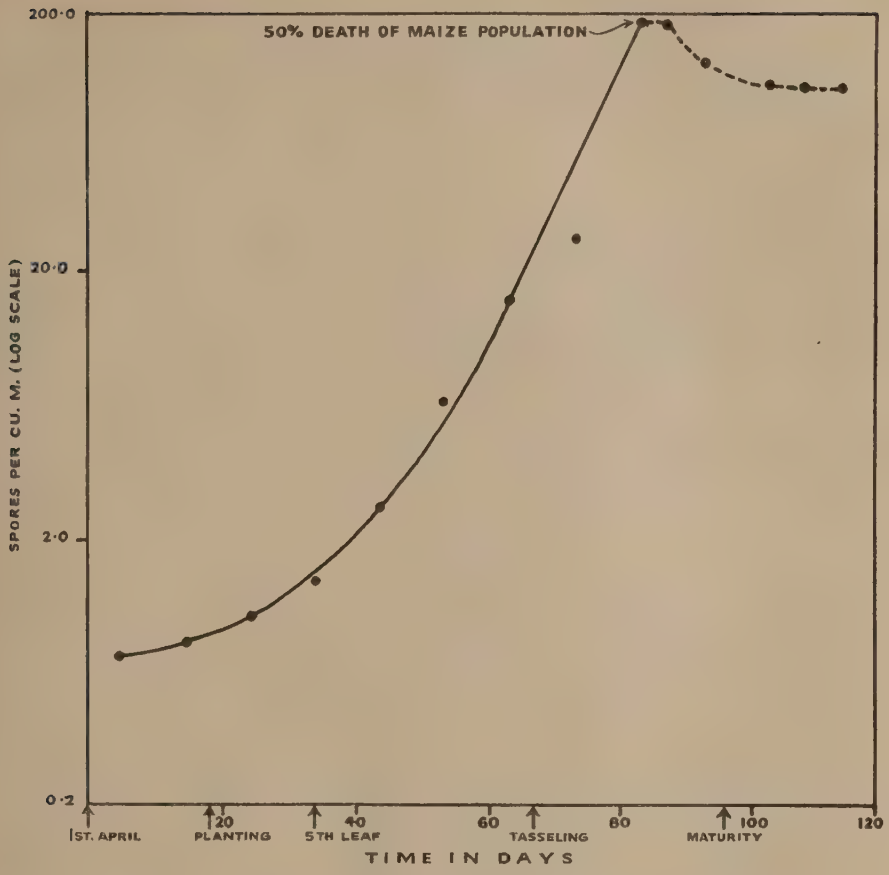


Figure III. The increase in the Uredospore Content of the atmosphere over a maize plot

PROGRESS REPORT ON A MAIZE SURVEY OF WEST AFRICA

Introduction

The recent epidemics of maize rust due to *Puccinia polysora* Underw., reported by Rhind (1952), have emphasized the need for increased research on maize in West Africa. In particular, they raised the question of mode and time of entry of maize into West Africa and its subsequent selection and distribution. A hypothesis to explain the

genetical constitution of West African maizes, primarily with reference to their susceptibility to *Puccinia polysora*, has been given by Stanton and Cammack (1953). A premise of this hypothesis was that maize was brought to West Africa by the Portuguese early in the 16th century, but, doubt has recently been cast on this by Jeffreys (1953). He found archaeological evidence for the existence of maize in West Africa some five hundred years prior to this date.

An analysis of the selection due to environment which has taken place in the past is important in breeding maize for West African conditions. This natural selection appears to have been modified to a greater or lesser extent by sociological factors which will be considered in the course of the survey.

This survey has been severely limited in scope by the methods available to us. Extensive use has been made of the services of the Departments of Agriculture of the British and French West African Governments. All governments approached to date have been extremely helpful in providing maps and data from a number of departments (i.e. Agriculture, Survey, Geology, Meteorology and the Institutes dealing with anthropological questions). The Agricultural Departments have given careful attention to the distribution of questionnaires and the checking and forwarding of samples.

Rationale, Material and Methods

The main task of the survey was to obtain samples of all the types of maize which exist in West Africa. These were to be brought back to the Unit and classified for type, colour and metrical characters. Replicated aliquots would then be sown and comparative observations taken on vegetative and floristic characters. Details of this will be mentioned later. The methods were designed after a study of the work on the origin of maize by Mangelsdorf and Reeves (1939) and the subsequent surveys on maize carried out in Mexico by Wellhausen and others (1952), Roberts (1954) in Colombia, Brown (1953) in the Carribean area, Paddock (1954) in Guatemala and Brieger (1954) and others in Brazil. The possibility of analysis of introgression between types from different areas by one or other methods reviewed by Anderson (1949) was considered.

As a long term part of the project comparative cultures of selected sub-samples would be grown in ecological zones different from those of the area sampled. Further subsamples would be selfed for the detection of latent gene frequencies.

The sampling and questionnaire took into consideration, as far as possible, the procedures as given by Yates (1953) and the terminology follows the definitions therein.

1. *The Sampling Frame*

The agricultural administration of British West Africa consists of a Director of Agriculture for each territory, and a number of agricultural officers each of whom is assigned to a political unit, the province. Within the provincial areas, divisions are allotted to agricultural assistants. In consultation with the departments it was consequently possible to obtain samples from each of the divisions where maize was grown. The rate of sampling was therefore defined as: "As many samples as there are varieties of maize in your division".

2. *Intensity of Sampling*

A suggestion was rejected, for practical reasons, of stratifying the population of maize types according to the intensity of maize growing in order to have a higher frequency of sampling in the intensive maize areas. In practice, the average rate of sampling achieved was one sample per 500 square miles, the intensity being above and below this according to the intensity of maize growing.

3. *Bias*

The frequency of sampling was controlled at agricultural officer level and these officers checked reports from their provinces before forwarding the data. A further check was obtained on excessive sampling by inspecting the closeness of identity of samples from a given division. Thus, for the purpose of obtaining the "number of types" in a given area it was possible to improve the estimate by amalgamating geographically and morphologically "close" samples.

4. *Method of Sampling*

A 500 grain sample of each variety was requested and the assistant was instructed to take this from shelled maize, if possible, and if not to collect by sampling from the mid-position of a number of ears in the crib or drying frame. Replicate samples have shown the actual error of estimation of "hundred grain weight".

5. *Sample Data*

A form was completed for each sample. A specimen of this is shown below (Fig. 1). It was designed to reduce the subjective data to a minimum. Referring to this form:—

Items 1-6 were incorporated for back reference where necessary.

Item 7 was included as the name of the variety often gives an indication of the value the local inhabitants attach to the crop (i.e. in areas where maize is of low importance the varieties are rarely distinguished by names). It may also give a clue to the varieties' origin (Jeffreys, 1953, loc. cit.).

Items 9-14. In practice, it is found that the standard of answer to these questions is very variable, but it is possible to extrapolate without danger owing to "similar maize areas" being a composite of several "observer areas". The "observer areas" were marked on a base map.

Item 15. In the preliminary instruction sheet this was defined as follows:

Intensive	maize main carbohydrate source.
Regular	maize an important carbohydrate source (but supplementary to cassava or guinea corn).
Sporadic	mainly a compound crop.

Items 16-17. A check on these could be obtained by reference to the appropriate authority, but the questions were inserted to attempt to reduce errors due to samples being taken from "islands" of a different soil or vegetation classification from that of the zone as a whole. The soil classification was put into terms of common usage in the agricultural departments as it was found that the correct technical terms could only be inserted where the assistant had a particular inclination towards the subject.

FIGURE 1

WEST AFRICAN MAIZE RUST RESEARCH UNIT

PROJECT WAMRRU 54/13. WAMRRU FORM NO. 37.

A SAMPLE SURVEY OF MAIZE IN NIGERIA,
THE GOLD COAST AND SIERRA LEONE

The answers to the questions in this form should be filled in by the Agricultural Assistant or Field Overseer collecting the maize sample:

PLEASE WRITE NEATLY IN PENCIL OR PEN, AND PLACE INSIDE THE COTTON BAG WITH THE SEED SAMPLE. TIE THE NECK OF THE BAG SECURELY AND SEND TO YOUR AGRICULTURAL OFFICER AS QUICKLY AS POSSIBLE

COLLECTION DATA

(1) Country (2) Region
(3) Province (4) Division
(5) Farmer's name
(6) Location
(Latitude and Longitude if possible)

DESCRIPTION OF VARIETY

(7) Name of variety (8) Seed colour
(9) Origin of the variety
(10) Use of the variety
(11) Is the variety important in the area?

(12) Does the farmer like yellow or white maize?
(13) Would he grow coloured maize (red, brown)?
(14) Would he mind if the maize was hard and flinty?

DESCRIPTION OF LOCALITY (*Delete the descriptions not applicable*)

(15) Intensity of maize growing: Intensive; regular; sporadic.
(16) Type of country?
Swamp; High Forest; Palm Forest; Dry Forest; Guinea Savannah.
(17) Soil: sand; loam; silt; laterite; black forest.

(18) General growth of arable crop in the area: good, medium, or poor.
(19) Agricultural Officer's comments
(*Please check in particular items* (6), (16), (17))
(20) Date of collection
(21) Signature and rank of collector
(22) Checked by:
(A.O.)
(District:)

Preliminary Results

Analysis of Results

The results given in this report are confined to observations on the samples as received

and to mapping the intensity of maize growing on the basis of information supplied by the completed questionnaires received with each sample. In checking data and plotting the results numerous maps had to be consulted; these were all of the scale 1 : 500,000 to 1 : 400,000. A list of maps is given at the end of the bibliography in this report.

The following observations were taken on each sample:

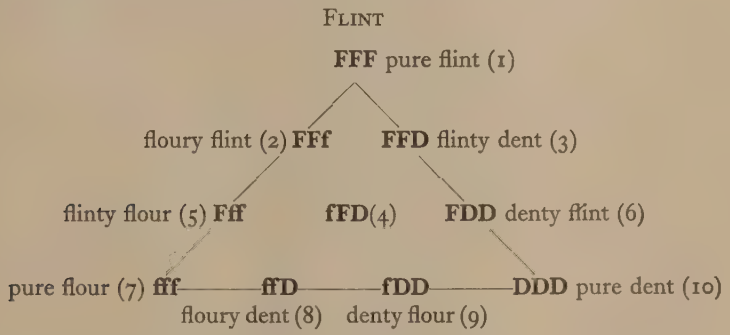
(*a*) colour
(*b*) Type
(*c*) Hundred grain weight

(*a*) The colour of the sample was classified as follows:

(7) **W** white
(6) **Y** pale yellow
(5) **YY** medium yellow
(4) **YYY** deep yellow, amber
(3) **R** reds
(2) **Br** browns
(1) **P** purples

Where a mixture occurred in the sample the percentage frequency was assessed. A note was added on the coloured samples, (1), (2) and (3) above. The significance of coloured samples will be discussed in more detail in later reports.

(*b*) Type was classified on a triangular co-ordinate plan:



(*c*) Size was classified on the basis of 100 grain weight:

(4) <17 gm.
(6) 17-23 gm. } per 100 grains
(8) > 23 gm.

The numbering in brackets was used to produce a simple index for plotting on maps so that areas of similar types might be picked out by inspection. The figures increase numerically from north to south for all these characters. Thus, on a combined index the values encountered in the south were between 20 and 27 and in the northern territories between 10 and 20.

TABLE 1

Key to Maize Distribution Map

Summary of maize types (grain characters only: a full description is in the Appendix to this report).

(Indicated on the map by a red line encircling the area in which the type predominates.) Grain sizes referred to below fall approximately within the following classes:

Dry 13% moisture grain weight of 100 grains.

Large	over 23 gm.
Medium	between 17 and 23 gm.
Small	under 17 gm.

Type	*Area*	*Description of grain type*
1.	Ogoja (Ibo)	Large, white floury grains with occasional purple samples.
2.	do.	Large, white floury grains, occasionally flinty, also with purple samples occurring.
3.	Ibibio	Medium-large, white floury grains, but pure dent and pure flint samples also occur frequently; yellow admixtures (rare) and red and purple grains (in one sample only). A heterogenous group.
4.	Owerri (Ibo)	Medium-large, yellow flinty grains. Great similarity between samples in this group.
5.	Delta (Urhobo)	Large-grained, yellow flint or flinty-dent grains. A homogeneous group clearly distinguishable from groups 6, 7 and 8.
6.	Kukuruku	White, flint grains with admixtures of floury flints and yellow contamination.
7.	Ife (Yoruba)	A heterogenous collection of yellow admixed with white grains intermediate between flint, dent and flour probably divisible into Ondo (white flints) Ilesha (very large grained yellow flinty-flours) and an Owo group (distinguishable from Ondo on vegetative characters). Yellow and flint characters are probably recent contaminants (<10 years from introduction).
8.	Ijebu (Yoruba)	Medium-sized grain, pure white floury-flints with frequent white flour samples. A uniform group in contrast to group 7.
9.	Egbado (Yoruba)	White, floury grains of medium size with some admixture of flint and dent and recent yellow contamination. This type straddles the boundary with Dahomey.
10.	Dahomey (South)	White flours or flinty flours with frequent yellow contamination and rare red and purple contamination. The effect of selection for the swamp soils of the Ouémé valley, the lagoonal sands and the red tropical clay areas necessitates detailed sub-division of this group.
11.	Keta	A uniform collection of white denty flour samples.
12.	Gold Coast Colony (Akan, Krobo, Ga-Adangme, etc.)	Predominantly medium-sized, white flour grains with rare yellow and very rare purple contamination. By far the largest and most important Gold Coast Group.
13.	Ho	Medium-large, white floury-flint grains without yellow contamination.
14.	Ashanti (South)	Large, white floury flints frequently admixed with dent samples. No yellow contamination.
15.	Ashanti (North)	Very large floury flints distinguished from the previous group by more flintiness and larger size.

The maize of regions north of the 7° parallel of latitude has not been investigated in detail as yet but it is clearly distinguished from southern maize. Small yellow flint types predominate with relatively frequent occurrence of coloured samples.

The areas of different types are shown on the map (Fig. 2). A full description of the grain samples is given in the appendix to this report. The types, as numbered on the map, are summarized in Table 1. The base colours of the map show the intensity of maize growing in different areas. This distribution is based on the original sampling reports, the actual samples being plotted on to a map as **I** (intensive), **R** (regular) and **S** (sporadic). The data concerning the northern maize types is incomplete owing to delays in receiving all the samples.

Nomenclature of a particular maize type has been based on either a tribal or linguistic group whichever fitted the better. These names then serve as a working hypothesis in investigating the problem of the effects of anthropological factors in differentiating the maize types.

Results

1. **Intensity Distribution.** It will be seen from the map (Fig. 2) that in comparison with the total area available for maize growing, the area in which it is grown as one of the chief sources of carbohydrate food, is comparatively small. Even where it is grown as a main crop it is only in very limited areas (extreme south-west corner of Nigeria, parts of southern Dahomey and south Ashanti and the Cape Coast area of the Gold Coast) that it may be regarded as the first source of foodstuff. Its importance in these areas can, however, be judged by the famine which occurred there during the maize rust epidemics of 1950 to 1951. Large quantities (of the order of 50,000 tons) were imported by these territories during this period. A history of this period is reported elsewhere (see bibliography).

Farther west the intensity of maize growing decreases until in the higher rainfall zones of Sierra Leone it becomes of comparatively minor importance in relation to rice. The statistics of relative production are given in the table below; a summary of reports from the World Census of Agriculture (1950) and the Sample Census of Agriculture, Nigeria (1952).

TABLE 2

Territory	Production per annum in tons	% Total grains produced	Approx. value in 1955
Nigeria	743,000	19.3	£20,061,000
Gold Coast	163,000	45.2	4,401,000
Sierra Leone	8,000	2.6	216,000
Gambia	1,500	3.3	40,000
Total	915,500		£24,718,500

The last column of the table refers to the value at world market price (£27 per ton). Since, however, it is one of a number of alternative sources of foodstuffs a more realistic

figure, in terms of the internal economy of the country, would be that of the cost of production "ex farms". The figures in the table would then be reduced to just over half (£15 per ton).

The distribution in West Africa is in marked contrast to the situation in East Africa where maize tends to be the dominant foodstuff over large areas of country more suited to the growth of sorghums. Sorghum growing and a preference for sorghums can be attributed to the Hausa more than to any other group. Nevertheless, as will be seen from the map (Fig. 2) in northern areas of Nigeria, Dahomey and the Gold Coast, maize is to be found as part of the cropping system and in compounds.

It is not possible to assign this intensity distribution to any one cause and further explanation must be provided in the discussion on particular types. For instance, any hypothesis that there is reduced maize growing in the forest and derived savannah zones where the soil is concretionary laterite is only partially true. Similarly, one finds attempts at intensive maize culture in the highly impoverished sandy soils around Porto Novo, Dahomey.

If the population maps of West Africa (see bibliography) are compared with the maize distribution maps it will be found that there is a good correlation, within the forest zones, between dense population and high intensity of maize cultivation in the forest area west of the Niger as far as the Cote d'Ivoire. North of the forest, in the Eastern Region of Nigeria and in Sierra Leone, this correlation does not hold.

In the highest rainfall areas maize growing is limited by endemic diseases such as *Helminthosporium turcicum* and other leaf blights. In parts of the Eastern Region, Nigeria, and in the Western Colony, Gold Coast, the level of infection with noctuid stem borers has apparently been the limiting factor in defining the acreage under the crop.

Tribe, tribal custom and language group has had a great effect both on intensity and type of maize production. The coastal strip retains many relict tribes with no agricultural traditions and this has been a barrier to the extended cultivation of both rice and maize. A relatively new intensive area is developing in the high Cameroons where a very primitive agrarian population exists.

One of the closest correlations between maize cultivation and ethnographical factors is that with the Baumann and Westermann (1948) cultural groups. The intensive area, with the exception of Bamenda, is confined within the "East Atlantic" culture. The relationship is much closer to this cultural pattern than to the grouping of peoples on a genetical basis. The northern peoples culture has spread to the limits of introgression of the northern races with the result that the northern agricultural pattern has been imposed on more southerly peoples.

A paradox in the consideration of anthropological relationships is the fact that the Semi-Bantu of West Africa do not show the strong preference for maize growing of the related East African peoples.

2. Type Distribution. Type, like intensity is dependent on a number of factors. The two variables are interrelated in that, as a generalization, type is not critical in areas of low intensity. Very low intensities do, however, affect type by limiting the panmixis of the maize population. The maize of the extreme north is grown as a compound crop in which five plants or fewer come into flower at the same time and the compounds are too widely separated for fertilization to be affected from other compounds.

Anthropological practices play the most important role. These can be divided as follows:

I. Sociology (including husbandry and seed storage).

II. Mode of consumption.

III. Religion, fetishism and superstition.

I. *Sociology.* The cultural habit of the Yorubas (particularly aggregation into large towns with farmers having only temporary dwellings on their farms) results in the mixing of strains over the whole area served by the town. (A farmer may obtain seed at planting time from a trader who has stored large supplies, or from another farmer who is selling off a surplus.) The "Yorubas" in this connection include those in Dahomey and the allied Benin groups.

The stability of types in Nigeria may be related to the map of Buchanan (Buchanan & Pugh, 1955) in which he shows "the major units in the cultural geography", (p. 87). It is found in the Eastern Region that the broad classifications, maize types 3 and 4 (Table 1 and Fig. 2), are further subdivisible. Such a division is not possible with types 12, 14 and 15 (Gold Coast types).

The main division in the southern Gold Coast is between the Ashanti and Ga-Adangme language groups, but the situation is confused by the north to south trade routes which traverse the east to west language boundary. Within both these groups free intermingling occurs.

As will be seen from the isohyet and vegetation maps of Dahomey, this territory is not comparable with its neighbours, and the unity imposed on the culture by the ancient Kingdom of Dahomey is disrupted by the two well differentiated topographical features of the Ouémé valley and its surrounding higher land.

The distinction between northern and southern maize is great enough to warrant the hypothesis that maize entered West Africa by two entirely separate modes. Probably the earlier was due to trans-Saharan trade and was followed at a much later date by a coastal introduction of more palatable flour types. Evidence for the first introduction is given by Jeffreys (1953), though his timing of the establishment of the Yoruba kingdom has not been substantiated, and he omits the explanation that the "Moorish" introduction may have been through the association with Spain at the time of the early voyages to America.

Finally, among the sociological factors are those influencing maturity time. The type, as found in any one area, may be of a much earlier maturity than that which would give the maximum yield, since it is required to fill a gap in the year's food supply or to fit in with a rotation in which it is not the most important crop. The Gold Coast variety "Frankadua" is widely recognized through Ashanti for this purpose and varieties with such names as "Forty-day" are also found in the southern Gold Coast.

II. *Mode of Consumption.* This factor defines the boundaries of the northern flints and the southern flours and dents. It also determines the areas in which coloured (red, purple) grains are to be found and the areas where either white or yellow grains are preferred or demanded.

III. *Religion, Fetishism and Superstition.* Scattered through the literature on the social anthropology of West African tribes are numerous references to the impact of these factors on the choice of foodstuffs and their mode of preparation, (Forde, 1951, Manoukian, 1950, 1952a and 1952b, Richard-Molard, 1949 and Baumann & Westermann, op. cit.).

This aspect of the survey still requires full analysis. So far, the following observations have been made. From the Ogoja area (type 1 and 2 on the map, Fig. 2) all samples were white with the exception of one purple sample but no objection was expressed on the questionnaire forms to the idea of accepting yellow or red maize. Farther south at Ikom, (6° 0′ N, 8° 50′ E) strong objection was raised to the suggestion of growing yellow or coloured maize. The Eastern Region presents a complex answer to the question of preference in that, farther south, at Afikpo (5° 50′ N, 7° 50′ E), the objection to yellow maize was absent although practically all the samples received were white. In the Delta and Owerri area (5°-6° N and 6°-7° N) yellow maize is grown and preferred.

In the Western Region definite preference is stated in the Kukuruku Division in the east (7° 10′ N, 6° 15′ E), Oyo in the west (7° 50′ N, 4° 0′ E), Ijebu (6° 50′ N, 4° 0′ E) and Ilaro (6° 50′ N, 3° 0′ E) in the south, for a white maize. In Benin (6° 20′ N, 5° 40′ E), Owo (7° 20′ N, 5° 40′ E), Ilesha (7° 40′ N, 5° 20′ E) and Okitipupa (6° 30′ N, 4° 50′ E) no such categorical preference is shown.

In Dahomey the strong preference for white maize appears to be mainly among the Yoruba speaking people of the south-west. In the north, around Djongon (9° 40′ N, 1° 40′ E), Nattingou (10° 15′ N, 1° 20′ E) Kandi (11° 10′ N, 2° 50′ E) no white maize is found. It appears in the Parakou area (9° 20′ N, 2° 40′ E) mixed with the yellow. South of Savalou (7° 50′ N, 2° 0′ E) white maize predominates, especially down the Ouémé valley. It will be seen from the map prepared by Mercier (1953) that the tribal differentiation is complex in the area north of Cotonou, viz. in the Ouémé valley and surrounding areas. In particular, a well-defined group occupies the Ouémé valley itself (the Ouéménou). This differentiation is reflected in the complex of varieties in the area.

The Gold Coast is notable for the presence of a large "obligatory white maize" area. This covers the whole of the Eastern Colony, (types 12, 13 and 14 on the map), Ho and South Ashanti areas. North Ashanti is partly an "obligatory white maize" area changing to a "white maize preferred" area around Wenchi (3° 50′ W, 7° 45′ N), (type 15).

Part of Ho (0° 30′ E, 6° 40′ N) is a "white maize preferred" area. This is a northern extension of the Ewe. Farther south (type 11) although a white maize area, it is uniform in its willingness (10 samples) to accept yellow maize, if provided.

No, or very little, preference for colour is expressed in Western Colony (Axim, Tarkwa, 4° 15′ W, 4° 52′ N). Two reports of "no preference" were received from Nsawam (0° 18′ W, 5° 45′ N). This is just outside the eastern border of Western Colony. It is outside the Ga-Adangme area and on the railway, the influence of which is marked in its "contaminating" effect, in the broadest sense, on populations due to the influx of traders and the flow of goods (McCubbin 1954).

Nine questionnaires (with samples), received from North West Ashanti (part of Wenchi), are recorded as stating no particular preference for white or yellow maize. A small area around Kpeye (0° 20′ E, 6° 40′ N) showed similar lack of preference.

The Black Volta provides a relatively sharp division between the Brong (Ashanti group)

and the various northern groups (Dagomba etc.). Preference predominates for the yellow flints in the areas from which samples have been received. These are mainly from the Tamale (0° 45′ W, 9° 20′ N) area and farther east towards Yendi. The population of this area is very low being from 0 to 50 persons per square mile and the samples are few in number.

Of exception are the results from Lawra (2° 50′ W, 10° 40′ N.). This is north-west of the Dagomba complex and is an area occupied by the Dagoti, and it was stated that white or yellow maize was equally acceptable. It will be necessary to investigate further just how far "necessity" has given rise to preference for yellow flints in these northern territories.

Discussion

It must be emphasized that this is an interim report in which an attempt has been made to classify samples on the characters observable in them. Further samples are still being received especially from the northern and more remote territories and there remains a wealth of data to be extracted from the questionnaires. However, this preliminary grouping is the hypothesis which is being used in observing the vegetative characters and, so far, it appears that where samples are of similar grain weight and type, from neighbouring and ecologically similar areas, the vegetative characters are also similar.

On the anthropological aspects of the study, the main problem is that of taxonomy. As yet the peoples of West Africa have not been classified comprehensively on measurable parameters, such as blood group frequencies, and existing recognized groups differ in their taxonomic justification for existence. Thus "Hausa" is used loosely as a tribal group though it is more correctly a collection of peoples having common language elements. It is this lack of uniformity which must be admitted in correlating maize types, preferences, modes of consumption, etc., with the anthropological classification.

Mercier quotes Richard-Molard as saying about ethnic grouping in his comments on Mercier's work: "It is a complex of the general way of living, habitat, dress, customs, beliefs and common elements of language. But it must be admitted that, in many instances, all these characters are far from being precise. We are forced at present to admitting, for want of anything better, that many an ethnic group rests solely on some concept of the make-up of its constituents".

To quote:

La définition que donnait J. Richard-Molard dans une note inédite traitant de cette entreprise cartographique nous paraît, dans sa souplesse, la plus commode: "C'est un complexe résultant à la fois du genre de vie matérielle, du genre d'habitat, du costume, de l'ensemble des coutume, des croyances, et aussi, bien entendu, souvent d'une relative comunauté de langage. Mais il faut avouer que, dans bien des cas, tous ces points sont encore loin d'être précisés et que nous sommes parfois réduits pour le moment à admettre, faute de mieux, que *tel groupe ethnique ne tient qu'à l'idée que ses membres s'en font.*"

Seed Distribution 1954

During the year it has been part of the Unit's policy to make the Regions of Nigeria and the other contributing territories independent of Ibadan for their stocks of the more important varieties for trial. These include Mexicans and a primary selection from the W. L. Brown collection (Trinidad collection).

This year a collection has been sent to Southern Rhodesia and small quantities of Mexican derivatives have been sent to Dahomey and the Cote d'Ivoire.

Seed Acquisitions 1954

A list, with comments on behaviour of the more important acquisitions, will be published with the 1955 Report. Brief comments are given below on the most important series received during the year.

I. *Acq. 306-307* (*South African lines*)

This group consisted of a large collection of inbreds sent by Dr. J. E. Van der Plank of the Union of South Africa, Department of Agriculture, for testing for polysora resistance. In trials under Ibadan conditions they failed practically completely and, where observation on *Puccinia polysora* resistance was possible, none was found.

II. *Acq. 704-737 and 753-755* (*Italian lines*)

Small collections of commercial Italian hybrids (Asgrow Seed Company) and inbreds were received from Professor Fenaroli of the Instituto de Maiscultura at Bergamo. These lines are of interest in that they mature remarkably early (seventy and forty-five days respectively with tasselling at forty-five and thirty days) under Ibadan conditions. Similar very early maturity was noticed in a group of inbreds received from Dr. Rinke of St. Paul, Minnesota, U.S.A.

III. *Acq. 738-749*

This was a very small group of genetic stocks from the Maize Genetics Co-operative Collection. Their use is reported elsewhere under genetic studies. Unfortunately most of the stocks were unsuited to the local environment and preliminary work will be necessary to modify the stocks before they can be employed successfully.

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APPENDIX I

Qualitative Seedling Reactions of New Acquisitions and Derived Lines

Key
s =selfed
s_2 =twice selfed
× =crossed
# =sibbed
A =acquisition number
P =progeny number

Variety		Qualitative rust reactions of seedlings
Progeny reference	Pedigree	
A. 83	*Derivatives of Acq. 83, Mexico 1*	
P. 2043	$\#_2 s_2$	1
P. 2047	$\#_2 s_2$	1
P. 1766	$\#_2 s_2$	2
P. 1648	$\#_2 s_2$	2
P. 1748	$\#_3 s_1$	1
P. 1919	$\#_2 s_2$	2
A. 84	*Derivatives of Acq. 84, Mexico 2*	
P. 1712	$\#_2 s_1$	4
P. 1713	$\#_3$	4
P. 1714	$\#_3$	4
P. 1717	$\#_2 s_1$	4
P. 1709	$\#_2 s_1$	4
A. 86	*Derivatives of Acq. 86, Mexico 4*	
P. 1738	$\#_1 s_3$	2
P. 678	s_4	4
A. 87	*Derivatives of Acq. 87, Mexico 5*	
P. 1658	$\#_2 s_2$	1
P. 1659	$\#_2 s_2$	1
P. 1661	$\#_2 s_2$	2
P. 1662	$\#_2 s_2$	1
P. 1649	$\#_2 s_2$	1
A. 89	*Derivatives of Acq. 89, Mexico 7*	
P. 1743	s_5	2
P. 1534	s_5	2
P. 1734	$\#_2$	2
A. 95	*Derivatives of Acq. 95, Mexico 13*	
P. 1568	$\#_2 s_1$	1
P. 1571	$\#_2 s_1$	0
P. 1834	$\#_2 s_1$	1
P. 1836	$\#_2 s_1$	1

APPENDIX I—*continued.*

Variety		Qualitative rust reactions of seedlings
Progeny reference	Pedigree	
A. 98	*Derivatives of Acq. 98, Mexico 16*	
P. 810	s_4	2
P. 1645	s_4	2
P. 1805	$\#_2$	2
A. 99	*Derivatives of Acq. 99, Mexico 17*	
P. 1789	$\#_3 s_1$	2
A. 103	*Derivatives of Acq. 103, Mexico 21*	
P. 1704	$\#_2 s_2$	2
A. 104	*Derivatives of Acq. 104, Mexico 22*	
P. 1706	$\#_2$	2
A. 26	*Derivative of Acq. 26, Mexican June*	
P. 1065	$\#_3$	4
	Trinidads	
P. 1849	Br. 125 Haiti$\#s_1$	2
P. 1844	Br. 129 Haiti$\#s_1$	2
P. 1847	Br. 130 Haiti$\#s_1$	2
P. 1856	Br. 132 Haiti$\#s_2$	1
P. 1820	Br. 167 Haiti$\#s_2$	2
	Florida lines	
A. 834	Tiquisate—3	1
A. 835	Tiquisate—10	2
A. 836	Francisca flint × White Tuxpan	2
A. 837	Yellow Tuxpan—6	4
A. 838	Yellow Tuxpan—7	4
A. 839	Yellow Tuxpan—12	4
A. 840	Agroc. sem. × Mayorbela—8	4
A. 841	Agroc. sem. × Mayorbela—9	1
A. 842	Agroc. sem. × Mayorbela—10	4
A. 843	Agroc. sem. × Mayorbela—19	4
A. 844	June—141	4
A. 845	June—165	4
A. 846	June—172	2
A. 848	767—307	2
	British Guiana varieties (Highland varieties)	
A. 758	Br. Guiana semi-dent	4
A. 759	Am. Indian mixed variety	4

APPENDIX I—*continued.*

Progeny reference	Variety: Pedigree	Qualitative rust reactions of seedlings
	Italian	
	1. *Bergamo inbreds* (> S_8) viz. received as inbreds	
P. 1494	W 32 .. .. .. s_1 (> Sq)	2
P. 1501	1 205 .. .. .. s_1	4
P. 1503	33—16 .. .. s_1	4
P. 1506	M 14 .. .. .. s_1	4
P. 1509	M 14 .. .. .. s_1	2
P. 1511	33—16 .. .. s_1	4
P. 1512	L 289 .. .. .. s_1	4
P. 1513	K 41 .. .. .. s_1	4
P. 1517	LO 44 .. .. s_1	2
P. 1519	LO 62 .. .. s_1	No germination
P. 1520	LO 44 .. .. s_1	4
P. 1522	LO 62 .. .. s_1	4
P. 1523	LO 62 .. .. s_1	4
	2. *Asgrow hybrids* (*4 way*)	
P. 1155	Asgrow Wisconsin 464 s_1	4
P. 1156	,, ,, 464 s_1	4
P. 1182	,, ,, 464 s_1	2
P. 1185	,, ,, 464 s_1	4
P. 1199	,, ,, 464 s_1	2
P. 1202	,, ,, 464 s_1	4
P. 1207	,, ,, 464 s_1	4
P. 1229	,, ,, 464 s_1	4
P. 1232	,, ,, 464 s_1	4
P. 1234	,, ,, 464 s_1	4
P. 1237	,, ,, 464 s_1	4
P. 1257	,, ,, 464 s_1	4
P. 1272	,, ,, 464 s_1	2
P. 1273	,, ,, 464 s_1	4
P. 1278	,, ,, 464 s_1	4
P. 1280	,, ,, 464 s_1	4
P. 1380	,, ,, 464 s_1	4
P. 1387	,, ,, 464 s_1	2
P. 1388	,, ,, 355 s_1	4
P. 1401	,, ,, 464 s_1	4
P. 1402	,, ,, 464 s_1	4
P. 1418	,, ,, 464 s_1	4
P. 1419	,, ,, 464 s_1	1

APPENDIX I—*continued.*

Variety		Qualitative rust reactions of seedlings
Progeny reference	Pedigree	
	E.A.A.F.R.O. lines: originating from Turrialba, Costa Rica	
A. 760	E.A.A.F.R.O. 225	4
A. 761	„ 226	4
A. 762	„ 227	4
A. 763	„ 228	4
A. 764	„ 229	4
A. 765	„ 230	4
A. 766	„ 231	4
A. 767	„ 232	No germination
A. 768	„ 233	4
A. 769	„ 234	2
A. 770	„ 235	2
A. 771	„ 236	2
A. 772	„ 237	4
A. 773	„ 238	4
A. 774	„ 239	4
A. 775	„ 240	4
A. 776	„ 241	2
A. 777	„ 242	4
A. 778	„ 243	4
A. 779	„ 244	4
A. 780	„ 245	4
A. 781	„ 246	4
A. 782	„ 247	4
A. 783	„ 248	4
A. 784	„ 249	4
A. 785	„ 250	4
A. 786	„ 251	4
A. 787	„ 252	4
A. 788	„ 253	2
A. 789	„ 254	4
A. 790	„ 255	4
A. 791	„ 256	4
A. 792	„ 257	4
A. 793	„ 258	2
A. 794	„ 259	4
A. 795	„ 260	2
A. 796	„ 261	No germination
A. 797	„ 262	2
A. 798	„ 263	2
A. 799	„ 264	4
A. 800	„ 265	4
— —	(Not received 266)	—
A. 801	„ 267	No germination
A. 802	„ 268	4

APPENDIX I—*continued.*

Progeny reference	Variety Pedigree	Qualitative rust reactions of seedlings
A. 803	E.A.A.F.R.O. 269	2
A. 804	„ 270	4
A. 805	„ 271	4
A. 806	„ 272	4
A. 807	„ 273	4
A. 808	„ 274	4
A. 809	„ 275	2
A. 810	„ 53191	2
A. 811	„ 53193	1
A. 812	„ 53194	2
A. 813	„ 53197	1
	W.A.M.R.R.U. hybrids	
P. 1140	Asgrow Wisc. 464×Mex. 1	4
P. 1179	Asgrow Wisc. 464×Mex. 1	4
P. 1228	Asgrow Wisc. 464×Mex. 1	4
P. 1242	Asgrow Wisc. 355×Mex. 1	2
P. 1246	Asgrow Wisc. 355×Mex. 1	4
P. 1328	Mex. 1×Asgrow Wisc. 464	2
P. 1329	Mex. 1×Asgrow Wisc. 464	2
P. 1331	Mex. 1×Asgrow Wisc. 464	2
P. 1332	Mex. 1×Asgrow Wisc. 464	2
P. 1423	Mex. 1×Asgrow Wisc. 464	2
P. 1426	Mex. 1×Asgrow Wisc. 464	2
P. 1427	Mex. 1×Asgrow Wisc. 464	2
P. 1451	Mex. 1×LO 57	4
P. 1465	Mex. 1×W 32	4
P. 1479	33—11×Mex. 1	4
P. 1480	Mex. 1×Minnesota	2
P. 1486	Mex. 1×Minnesota	2
P. 1487	W. 32×Mex. 1	4
P. 1488	LO 107×Mex. 1	4
P. 1490	LO 107×Mex. 1	2
P. 1491	LO 107×Mex. 1	4
P. 1496	LO 107×Mex. 1	4
P. 1595	Mex. 1×WF 9	4
P. 1596	Mex. 1×Minnesota	2
P. 1860	(L. Wh.×Wh. Tux.)×Mex. 13	4

Note. The qualitative assessment represents 95% or higher of the progenies with the exception of the 'W.A.M.R.R.U. hybrid' group. These show a higher degree of heterogenicity and there are anomalies in the reactions of reciprocal crosses in that there is preliminary evidence of a higher degree of resistance using the resistant parent as female. Reciprocal crosses of this type are being further investigated.

APPENDIX II

MAIZE TYPES IN WEST AFRICA

NIGERIA

Type	Anthropology	Demography (persons per sq. m.)	Vegetation Zone	Soils	Reference No. and Name of Variety	Sub. var. no.	Grain Character: Colour	Grain Character: Type	Grain Character: Size+	Dominant Type	Days to Maturity	Use
1	Ogoja (Ibo)	100-200	Lowland rain forest	Predominantly reddish friable porous sands to sandy clays, Concretionary ironstone masses in the profile.	90 Ogoja	— 3	P	fff	12.5	Large white floury grains		a,b c
					84 Obudu/Ogoja	— 1	W	fff	18.5			
					87 Obudu	— 4						
					86 Obudu	— 3	W	fff	24.4	Note 1		
					85 Obudu/Ogoja	— 2	W	fff	25.4			
							W	Fff	28.4			
2	Ogoja (Ibo)	100-200	Derived savannah with relict forest	As in Type 1 (above)	91 Ogoja	— 4	P	fff	12.5	Large white floury grains		a,b e,f
					89 Ogoja	— 2	W	fff	24.0			
					88 Ogoja	— 1	W	fff	31.8			
3	Ogoja (Ibo) and Calabar (Ibibio)	100-200 In Uyo area; 100-300 in Afikpo area; And over 300 in Ikot Ekpene area	Lowland rain forest	(*a*) Predominantly reddish friable, porous clays to sandy clays (*b*) Yellowish-brown friable porous sands to sandy clays	119 Calabar	— 2	W	fff	16.3	Large white floury grains		a,b e
					101 Afikpo	— 3	Y	fff	18.2			
					78 Abakaliki	— 1	W	fff	19.0			
					110 Enyong	— 2	W	fff	19.0			
					105 Afikpo	— 7	W	Dff	19.0			
					109 Enyong	— 1	W	fff	20.0			
					100 Afikpo	— 2	YYY	FFf	20.3			
					124 Itu	— 3	W	FFF	20.8			
					118 Calabar	— 1	W	fff	20.8			
					123 Itu	— 2	W	fff	21.0			
					125 Ikot Ekpene	— 3	W	Dff	21.0			
					111 Ikot Ekpene	— 1	W	Fff	21.3			
					106 Itu	— 1	W	fff	21.8			
					112 Ikot Ekpene	— 2	W	fff	22.9			
					103 Afikpo	— 5	W	Fff	24.2			
					114 Uyo	— 2	W	fff	24.5			
					115 Abak	— 1	W	FFF	25.0			
					104 Afikpo	— 6	W/Y/R P	fff	25.8			
					113 Uyo	— 1	W	FFF	26.1			
					116 Abak	— 2	W	FFF	30.8			
4	Owerri (Ibo)	Over 300	Lowland rain forest	Predominantly reddish friable porous sands to sandy clays	129 Orlu	— 3	Y	FFF	20.0	Large yellow flinty grains		a,b,c e,f
					130 Orlu	— 4	YYY	FFF	20.5			
					128 Orlu	— 2	YYY	FFF	25.2			
					131 Orlu	— 5	YYY	FFF	25.7			
					127 Orlu	— 1	W	FFF	26.2			
5	Delta (Urhobo)	100-200	Derived savannah with relict forest (an inlier in a high forest area)	Yellowish-brown friable porous sands to sandy clays	3 Delta	— 3	YYY	FFF	14.9	Large yellow flinty grains		a,b f
					4 Delta	— 4	YYY	FFF	21.1			
					6 Delta	— 6	YYY	FFF	22.7			
					7 Delta	— 7	P	FDf	24.1	2-2.5 m. 100 day.		
					5 Delta	— 5	YY	FFF	25.8	Very stout stems,		
					8 Delta	— 8	YYY	FFF	26.0	tillering freely, ears of medium size		
6	Kukuruku (Edo-Bini)	40-100	Derived savannah zone with relict forest	Predominantly reddish friable porous sands to sandy clays	70 Kukuruku	— 3	W	FFF	16.3	Medium-sized white flinty grains		
					71 Kukuruku	— 4	W	FFF	17.4			
					69 Kukuruku	— 2	YY	FFf	18.1			
					72 Kukuruku	— 5	W	FFF	23.7	Note 1		
7	Ife (Yoruba)	40-100 in Ado Ekiti area, and 100-200 in Ilesha area	Lowland rain forest	Predominantly reddish friable porous clays to sandy clays	25 Ekiti	— 1	YY	FDf	14.6	Flint to floury-flint types slightly mixed with FDf types		a,b,c a,e,f
					27 Ekiti	— 3	YYY	FFf	18.6			
					63 Ilesha	— 2	YY	FFf	20.1			
					30 Owo	— 2	YY	FFf	23.3			
					28 Ekiti	— 4	YYY	FFF	23.4	Ekiti lines: 2.5 m.		
					26 Ekiti	— 2	YYY	FDf	23.9	90 day small ears		
					67 Ondo	— 2	YYY	FFF	24.0			
					24 Ondo	— 1	W	FFF	24.0	Ilesha lines: 2.5 m.		
					62 Ilesha	— 1	W	Fff	24.3	90 day small ears		
					64 Ilesha	— 3	YYY	FFf	25.0			
					65 Ilesha	— 4	YYY	FFf	30.1	Owo lines: 2.5 m.		
					29 Owo	— 1	W	Fff	30.7	90 days. Large white grained ears		
										Ondo lines: 2.5 m. 90 day medium-sized white grained ears		

APPENDIX II—*continued*

Type	Anthropology	Demography (persons per sq. m.)	Vegetation Zone	Soils	Reference No. and Name of Variety	Sub. var. no.	Grain Character: Colour	Grain Character: Type	Grain Character: Size†	Dominant Type	Days to Maturity	Use: 1	2	3	4	5	6	7	8
8	Ijebu (Yoruba) *This includes parts of the Colony*	100-200	Lowland rain forest	Predominantly reddish friable porous sands to sandy clays	9 Ikeja	— 1	W	FFF	10.6	Medium-sized flint types of grain		a,b	e,f		h				
					36 Owode	— 1	W	FFF	11.5										
					13 Epe	— 1	W	fff	12.9										
					18 Epe	— 3	W	FFF	15.6	Ikeja lines: 1.5-2 m. 80 day small ears									
					16 Epe	— 4	W	FFF	15.7										
					22 Ikorodu	— 2	W	FFF	16.0										
					23 Ikorodu	— 3	W	FFF	16.8	Epe lines: 1.5-2 m. 80 days small medium ears									
					14 Epe	— 2	W	FFF	17.0										
					10 Ikeja	— 2	YYY	FFF	17.4										
					12 Ikeja	— 4	W	FFF	17.8										
					15 Epe	— 3	W	FFF	19.8	Ikorodu lines: 1.8 m. 80 day medium ear. White grain									
					51 Ijebu	— 6	W	fff	17.0										
					49 Ijebu	— 4	W	FFF	17.3										
					48 Ijebu	— 3	W	FFF	18.0										
					47 Ijebu	— 2	W	FFF	19.6										
					17 Epe	— 5	W	FFf	21.3	Ijebu lines: 2-2.5 m. 80-90 day medium ears white grain									
					50 Ijebu	— 5	W	FFf	21.3										
					46 Ijebu	— 1	W	FFF	25.0										
					52 Ijebu	— 7	W	FFF	25.0										
9	Egbado (Yoruba) Anago (Yoruba) (ii) Goun (quasi Yoruba) part of the S.E. Dahomey complex	100-200 in Egbado-Yoruba and 300-500 in Avrankou area (Dahomey)	Lowland rain forest	Predominantly reddish friable sands to sandy clays	(i)							a,b	e,f		h				
					45 Ifonyintedo		W	Dff	20.0	White floury types									
					40 Ipokia		W	fff	27.6										
					38 Itaegbe		W	—	—	Ifonyintedo 2 m. 75 day med.-small ears, white grain									
					(ii)														
					1 Dahomey	— 1	W	fff	22.2										
					4 Dahomey	— 4	YY/W	Fff	24.3	Ipokia 2 m. 80 day large diam. ears									
										(see text)				DAHOMEY					
10	*Mixed* Toffinou (Coastal) Ouemenou Fon Mabi Agonlinou Houeda Aizo and others (Southern Dahomey complex)	100-200 with Porto-Novo area exceeding this figure	Secondary forest with cleared swamp vegetation in the Oueme valley (Porto-Novo area)	do	25 Dahomey (Aizo)	—25	W	fff	15.3										
					29 Dahomey (Fon)	—29	W	fff	15.3										
					14 Dahomey (Fon)	—14	W	FFf	15.5		60-90	a,b	*						
					15 Dahomey (Fon)	—15	R	fff	16.5		60-90	a,b	*						
					10 Dahomey (Fon)	—10	YYY	FFF	17.1		60		*						
					9 Dahomey (Fon)	— 9	YY	FFf	18.8										
					7 Dahomey (Kentou & Fon)	— 7	W	fff	19.5										
					16 Dahomey (Fon)	—16	W	fff	20.2										
					45 Dahomey (Fon & Houeda)	—45	YYY	FFF	20.7		90	c			*				
					12 Dahomey (Fon)	—12	W/P	Fff	21.1		60-90	a,b	*						
					11 Dahomey (Fon)	—11	W	fff	22.1		60-90	a,b	*						
					1 Dahomey (Ouemenou)	— 1	W	fff	22.2		110-120	a,b	*		*				
					13 Dahomey (Fon)	—13	W	Dff	22.9										
					48 Dahomey (Aizo)	—48	W/Y	Fff	23.4										
					26 Dahomey (Kentou)	—26	Y	fff	24.0										
					4 Dahomey (Toffinou)	— 4	Y/W	Fff	24.3		80-90		*				*		
					24 Dahomey (Fon)	—24	W	FFF	25.4										
					2 Dahomey (Ouemenou)	— 2	Y	fff	26.6		110-120								
					3 Dahomey (Ouemenou)	— 3	W/Y	Fff	27.8		80-90						*		
														GOLD COAST					
11	(Gold Coast) Ewe	100-200	Guinea savannah with strand and mangrove vegetation in the Keta district	Red porous sands	113 Keta	—12	W	fff	19.0	White denty flour types			c,f				j,k	m	
					42 Keta	— 9	W	fff	19.6										
					41 Keta	— 8	W	Dff	21.6										
					114 Keta	—13	W	Dff	21.7										
					43 Keta	—10	W	Dff	24.2								1		
12	Akan, Krobo, Akim and Ga-Adangme (Ga-Adangme)	100-200 and over 200 in Akwapim and Swedru area	(i) Guinea savannah (ii) Woodland in Ada district (iii) Antiarischlorophora association in Volta River district (iv) Celtis-Triplo chiton association in Nsiwam district	Red clays west from Accra to black clays near the coast (near Winneba). Black intractable clays on the Accra plain with reddish friable sands to sandy clays on the Aburi scarp	74 Blinkusese	— 1	W	?	13.9	Predominantly large white flour types		a,b	f,e				j,k	m	
					70 Tsotsuru		W	Fff	16.8										
					65 Ayigbe able		W	fff	17.75										
					140 Oloto	—11	W	fff	17.75										
					80 Blinkusese	— 2	W	fff	17.8										
					62 Kokodibara		W/P	fff	18.8										
					173 Abonsam aburow		P	FFF	18.8										
					72 Adzebli	— 1	W/Y	fff	18.0										
					77 Dzinuevebli		W	fff	20.4										
					176 Aburow Tumtum		P/W	fff	21.0										
					146 Oloto	—17	W	fff	21.0										
					144 Oloto	—15	W	fff	21.5										
					185 Peki/Akwanu	— 3	W	fff	22.4										
					60 Konkonkron		Y	fff	22.5										
					67 Kpedevi		W	FFf	22.8										

Type	Anthropology	Demography (persons per sq. m.)	Vegetation Zone	Soils	Reference No. and Name of Variety	Sub. var. no.	Grain Character: Colour	Grain Character: Type	Grain Character: Size†	Dominant Type	Days to Maturity	Use: 1	2	3	4	5	6	7	8
												GOLD COAST (*contd.*)							
12 (*Contd.*)					145 Oloto	—16	W	Dff	22.5										
					75 Worbli		W	fff	23.0										
					174 Konkonkron	— 2	W/Y	Dff	23.9										
					183 Peki/Akwanu	— 1	W	fff	23.6										
					184 Peki/Akwanu	— 2	W	fff	23.9										
					109 Oletievei	— 1	W	Dff	24.0										
					143 Oloto	—14	W	Dff	24.0										
					175 Asram Aburow		W	Fff	24.1										
					61 Kpaglo		W	FDf	24.2										
					186 Peki/Akwanu	— 4	W	fff	24.2										
					117 Anlo Maize		W	Fff	24.3										
					148 Oloto	—19	W/Y	fff/fff	24.2										
					76 Dakpa		W	fff	24.7										
					66 Aburow-pa		W	FFf	25.5										
					134 Oloto	— 5	W	Dff	25.8										
					133 Oloto	— 4	W	fff	26.2										
					63 Bonsam-aburow		P	fff	26.8										
					82 Adzebli	— 3	W	FFf	27.8										
					159 Aburow-pa	— 5	W	fff	28.9										
13	Krachi (and part of Ewe)	0-10 in Akim district 50-100 in Ho district	Guinea savannah-woodland	Reddish sands to sandy clays	49 Kpeli	— 2	W	fff	19.5	Large white grains			e,f				j		
					45 Adaduakron		W	FFf	19.6										
					46 Adaduanan		W	FFf	22.8										
					106 Ebsey	— 1	W	Fff	23.5										
					44 Adaduakron	— 1	W	FFf	33.6										
					51 Gbibli		W	Dff	33.6										
					107 Ebsey	— 2	W	?	?										
					48 Kpeli	— 1	W	?	?										
14	Ashanti—(Gold Coast)	50-100	Zone lies between the Celtis Triplo association and the Antiaris-chlorophora association	Pale buff-coloured sandy clays to sands	180 Adaduanan-Aburow	— 2	W	FFf	19.9	,,		a	f,e	g		j,k	m		
					181 Adaduanan-Aburow	— 3	W	Dff	23.6										
					177 Aburone-Nkate		W/P	FFf	24.6										
					162 Aburow/Pa	— 8	W	FDf	24.9										
					169 Kwahu-Aburow	— 1	W	fff	26.6										
					164 Aburow/Pa	—10	W	FFf	27.5										
					167 Asramienu		W	Fff	31.3										
					170 Kwahu-Aburow	— 2	W	FFf	29.1										
					166 Aburow Pa	—12	W	FDf	31.5										
					161 Aburow Pa	— 7	W	FFf	38.0										
					179 Adaduanan-Aburow	— 1	W	FDf	33.3										
15	Ashanti (Gold Coast)	25-100 (25-50 in Mampong area and 50-100 in Ofinso area)	Antiaris-chlorophora association in Mampong area and Celtis-Triplo chiton association in Kumasi area	Reddish clays, sandy clays and sands	91 Aburow	— 3	W	FFF	20.3	Large floury flint grains		(a) (b)	e,f		j		n,m		
					7 Ashanti	— 7	W	FFf	22.8										
					88 Ashanti	—29	W	Fff	28.8										
					84 Aburow	— 1	W	FDf	22.9										
					9 Ashanti	— 9	W	FFf	28.7										
					86 Ashanti	—27	W	FFf	25.4										
					92 Ashanti	—30	W	FFf	36.5										

* Means that the particular variety is consumed according to the above figures, viz., 1, 2, 3 or 4, etc., which are explained in the table of uses (q.v.).
† Size = weight at 100 grains in grammes.
Note 1 See description of grain type in text p. 36.

APPENDIX III

SUPPLEMENTARY TABLE TO 'USES' OF MAIZE IN SURVEY ANALYSIS TABLE

		NIGERIA				DAHOMEY	GOLD COAST AND TOGO		
		NORTHERN	WESTERN	EASTERN			NORTH	SOUTH	SOUTH-WEST
LANGUAGE:		Hausa	Yoruba	Ibo	Effik		Hausa	(Twi, Fanti, Ashanti)	Ewe Ga
GENERAL NAME FOR MAIZE:		Masara	Agbado	Oka	Ibokpot		Masara	Aburow	Aburow Abele
Mode of Consumption							(as for Nigeria)		
1. GREEN	(a) Boiled	Masara ndafa	Agbado sise	Oka esiriesi	Osobo Ibokpot				
	(b) Roasted		Agbado sunsun	Oka arurnaru	Ofop Ibokpot				
	(c) Pounded and boiled (Corn Cake)	Dankowa	Kango	Ekereke (Umuahia) Ikpakiri (Orlu)	Editim Ibokpot Ekoki	Gruau (Bariba)		Fomfom (Fanti)	
2. FLOUR	(d) Oiled paste fried		Adun	—	—				
	(e) Watery paste boiled into pap	Akamu	Ogi	Akamu	Ogi			Akassa (Fanti); Koko (Twi)	
	(f) Paste boiled into solid and wrapped		Eko	Agidi	Agidi	Mahoué		Kafa (Kwahu and Akim) Agidi (Akwapim)	
3. GERMINATED GRAIN	(g) Beers	Burukutu	Burukutu (Thick) Pito (Clear)	Burukutu (Thick) Pito (Clear)	Pito, Kwacha (local name for Burukutu)	Tamon-Souan			
4. ANIMAL FOOD	(h) Poultry (i) Pigs								
5. FERMENTED PASTE	(j) Mixed with raw flour and boiled twice	Agidi	Agidi			Akassa (Bariba)		Kenky (Pidgin) Dokono (Twi)	Komi (Ga)
	(k) Cooked		Akara Agbado (Fried) Ekuru Agbado (Boiled in leaf)					Banku (Twi)	
	(l) Made into balls and baked	Kose-Masara						Abodo (Twi)	Abolo (Ewe)
6. POUNDED GRAINS	(m) Fried mixed with ripe plantains		Kango					Krakro (Twi)	Kaklo (Ewe)
	(n) Cooked into Porridge		Akamu						
	(o) Cooked with ripe plantain							Akankyie (Ashanti and Kwahu)	
7. CEREMONIAL PURPOSES 8.	(p) Dry or wet grains cooked with bread fruit (*Treculia africana*)			Ahu oka (Orlu area)					
9. MISCELLANEOUS	(q) Dry grains fried (pop)		Guguru	Udo akpuenyi (Onitsha)	Edifran Ibokpot				

NOTE: The above list is not exhaustive and the collection is being continued. It represents the more important uses in the area under consideration.

A few omissions occur through lack of agreement on the correct assignment of names. Names tend to be common to a language group as often happens with imported customs.